HH3.2:H81/9

PUBLIC HOUSING DESIGN

a review of experience in low-rent housing

DRURY COLLEGE LIBRARY
Springfield, Missouri

NATIONAL HOUSING AGENCY · FEDERAL PUBLIC HOUSING AUTHORITY

From the collection of the

z n m
o Prelinger a
v Library
t p

San Francisco, California
2006

PUBLIC HOUSING DESIGN

UNITED STATES
GOVERNMENT PRINTING OFFICE
for sale by
Superintendent of Documents, Washington 25, D. C.
price $1.25

PUBLIC HOUSING DESIGN

a review of experience in low-rent housing

JUNE 1946

NATIONAL HOUSING AGENCY
FEDERAL PUBLIC HOUSING AUTHORITY

WE ARE on the threshold of a tremendous building boom! At the outset the immediate goal will be houses—good houses—for our veterans; but at the same time work must get under way to provide good housing for all people of whatever calling, race, or income group.

Another reality confronts us. The past decade has seen a trend toward community developments as distinguished from haphazard, scattered lot or subdivision building. More and more it is becoming evident that the well planned and executed community development is both a good business risk and a desirable place to live.

In such a situation we deem it our obligation to share with local housing authorities, private builders, architects, engineers, mortgage lenders, and the whole fraternity of personalities who encompass the residential building complex our experiences both good and bad in a decade of public housing endeavor. It may be quite unorthodox to unearth the skeletons of the mistakes that have been made, but we believe it to be our duty as a public agency to caution against error in which we may have participated in good faith as well as modestly to acclaim our achievements.

Necessarily the data presented are predicated on public housing experience. However, the private builder who has committed himself to meet the needs of more middle-income families and some lower-income families will find much profit in studying the contents. Likewise, the developer who seeks to enter the rental field will benefit from this material which deals so extensively with the struggle between capital cost and maintenance, replacement and operating expenditures. Low capital cost may or may not produce the lowest net cost for housing. The eternal search is to achieve both.

The local housing authority and its staff including its architects and engineers should consider this volume required reading. Much of it is technical, yet the lay member of a housing authority can function better by acquainting himself with its text. The mystery of the architect's and engineer's function in the development of public housing can be more readily appreciated. His problems may take on a different meaning from a basic understanding of the key discussions contained herein. It is not altogether fair to blame the architect and engineer for all the mistakes. Sometimes they have reluctantly followed the demands of the housing authority. A more sympathetic concept of the whole problem should arise from a careful reading of this release by both lay and professional people concerned with public housing.

We are mindful that many will disagree with some of the conclusions. Some will do so because they feel our opinions to be in error. Some may be motivated by selfish interests to disagree with recommendations for or against certain types of design materials or methods. Others will think the ideas too bold; some will believe them meek and too conservative. This publication is not issued as a mandate. It is an honest effort to discover the good and bad in our experiences. Opinions on such a score will differ, even as there are differences on some of the subject matter within our own organization. If the expressions set forth stimulate healthy discussions and a searching for even better answers, no matter how violent may be the differences of opinion, then this publication completely justifies itself.

You will note that many sources were tapped for the material. Our appreciation is offered to them. However, special mention must be made of a few. The basic responsibility for the publication rests with the Development and Reutilization Branch of the Federal Public Housing Authority under the leadership of Assistant Commissioner William P. Seaver. Under him in direct charge of the task was Gilbert L. Rodier, Director of the Technical Division, who was ably assisted by his entire staff but notably by Elisabeth Coit. On frequent occasions the advice and guidance on broad principles was secured from the FPHA Architectural Advisory Committee headed by Mr. Howard Myers. To these persons and to the host of others who made their contributions I express my deep gratitude.

PHILIP M. KLUTZNICK
COMMISSIONER

Foreword

This review, a summary of experience gained during more than a decade in planning low-rent developments, is offered to housing authorities and to their professional advisers and technicians to point out some mistakes and to chronicle some solutions of problems encountered. Unlike the "Minimum Physical Standards and Criteria for Planning and Design of FPHA-Aided Public Housing Projects," published by FPHA in 1945, it contains no rules which must be followed to satisfy legislative requirements.

Data of the type found in standard textbooks and in other reference sources have, in general, been omitted. The FPHA will continue to issue from time to time detailed technical information pertinent to public housing.

Acknowledgment is made and hearty thanks are offered to the authors of many reports which have supplied information and critical comments briefed throughout the volume. These reports have come from regional offices, housing authorities, project managers, and specialists in various phases of low-rent developments.

Equal acknowledgment is made also for the assistance given by the Library of Congress, the National Housing Agency's Information Division and to a number of local housing authorities who have provided some of the photographs here reproduced.

Readers, we assume, will not be misled by the contradiction between certain quotations. This contradiction is one of their chief advantages, for it underlines the fact that there is no one single formula to produce a perfect housing project.

The order of the chapters is arbitrary. The design of a low-rent development has many sides; choice of a site, dwelling layout, building material, land use, and so on. None of these can be considered separately. The reader will get most value from balancing the relation of the subjects discussed under all of the chapters.

It is hoped that this review may stimulate thought on the special nature and requirements of each public housing development and the different combinations of problems that are faced by each local housing authority.

Contents

Page

FOREWORD vi

GENERAL CONSIDERATIONS OF PROJECT DESIGN 1

SITE SELECTION 5

THE SITE PLAN 23

THE DWELLING TYPE: PROJECT DENSITY 73

THE DWELLING PLAN 93

COMMUNITY BUILDINGS AND OTHER SERVICE STRUCTURES 119

SITE ENGINEERING 149

THE STRUCTURE: ITS DESIGN AND MATERIALS 185

SELECTION OF UTILITIES 215

MECHANICAL AND ELECTRICAL DESIGN 221

LAWNS AND PLANTING 273

Index 285

PARK
VALLEY
PARK

General Considerations of Project Design

At the moment that many housing authorities are about to undertake large-scale programs of slum clearance and low-rent public housing, the FPHA offers the extensive experience collected from nearly four hundred low-rent projects, containing over a hundred thousand dwelling units, built and occupied long enough to provide reliable data. To record this experience and reasonable conclusions drawn from it is the sole objective of this review.

The field is so wide that it is difficult to summarize all of the items of importance noted in the record of experience. Indeed, it becomes more and more evident that the very nature of the problem forces a condition in which well rounded balance of all the factors appears more desirable than the overstressing of a few items, however important these may be. It does seem fitting, nevertheless, to underscore some of the more pointed conclusions drawn from this study and to note them here, together with such observations as may aid in developing the over-all design for a project.

Attention to these points is essential to the success of a development: The project is to be used over a long period of time and under a management responsible for the use of public funds; hence it must be so planned as to afford continued usefulness, and so constructed as to keep down the cost of repairs, maintenance and replacements, thus making possible the continuation of low rents. Low capital cost is important, but skimping in the wrong places overburdens the operating budget. Money spent for justifiable amenity is well spent, and will pay future dividends. The management of a project is no less important than its physical form: the program of operation should be formulated at a very early stage and reflected in the project design. However convenient to the tenant and satisfying to the eye, the project which cannot be operated smoothly and at low cost is not a successful one.

In the past, as now, the cost of every project was required to be within a definite limit. It is noteworthy and commendable that a large proportion of them were well within this limit.

But it became almost a routine, during the planning stages, to go through a process of trimming and slashing after bids were received in order to meet estimates, with, in many cases, unfortunate results. No job can undergo such a lopping-off and come out as well as a job planned to meet a predetermined price.

There is only one way to avoid this mistake: planners must know thoroughly the costs of materials and equipment in place; they must start their first studies with these costs in mind, and continually check and recheck probable costs as the sketches develop into working drawings. At any point, if higher costs than those anticipated appear, the underlying reasons should be recognized frankly and should be faced without compromise, even if this means a complete retracing of all steps back to the original studies. Such a procedure will more than pay its way in time saved, and in cost reduction.

While low initial costs and operating expense have been essential to the success of public housing, the present forecast of rising costs gives this subject even more weight today.

THE SITE

The choice of a site has great influence on the degree of integration the housing project will maintain in the development of long-range community plans. Careful deliberation about the present and expected future relation of different sites to the whole community is necessary if the project is to succeed in being a natural and happy part of its surroundings.

THE SITE PLAN

On the site plan depends smooth functioning of services and communications, convenience and livability for the tenants, good arrangement of facilities for recreation and play, with opportunity for tenant care and cultivation of the grounds. And all of this with amenity, order and economy.

DWELLING TYPES

Site density and site coverage are controlled largely by the dwelling type chosen: detached or row houses, flats, apartments, or other types or combinations of types. A common error is to start with a desired density, sometimes even before the site has been chosen, and then to force an unnatural condition by arbitrary use of types producing that density. Rather, the relation of site conditions, land and construction costs and local customs influence the range of desirable densities for the particular project which is being planned.

THE DWELLING PLAN

The purpose of public housing is to provide healthful conditions for the growth and development of family life and, especially, of children. This should be considered in every step of project design, and particularly in planning the dwelling unit. In public housing, where every penny counts, dwellings must be designed for living in, and not merely for the pleasure of their designers. The legitimate desires, hopes, ambitions and cultural aspirations of the tenants—no less important than their material needs—combined with the economy necessary in low-rent work constitute a far from simple challenge to those designers.

COMMUNITY BUILDINGS

These, adequately planned and properly located, will accommodate efficient management, maintenance, and operating services, and will provide for indoor tenant group activities. Assembly rooms, play and recreation space, child care and clinic facilities, and other related services, all these are possible project needs. The project center buildings will justify their existence by their usefulness: The center should not be thought of as an architectural *tour de force* but as an essential part of the whole; something really to serve the tenant and the management staff.

SITE ENGINEERING

Roads and walk construction, grading and drainage have proved, in past experience, to be possible sources of heavy operation expense. Correct design, durable materials, and, in particular, careful supervision will prevent these details from claiming more than their fair proportion of maintenance costs.

THE STRUCTURE

Public housing has offered little for criticism so far as structural simplicity and stability are concerned. The buildings are, by and large, sound and will remain sound through the term of years for which they are planned. The skill used in adapting straightforward large-scale construction methods to the complicated planning patterns of small domestic living quarters is a distinct contribution to the art of building. But the planner will do well to give special attention to details which have given particular trouble in the past, such as: leaking walls, cracked masonry, porch foundation settlement, damp crawl spaces, condensation, movement of parapets, and inadequate flashing.

SELECTION OF UTILITIES

The wholesale or other favorable purchase of utilities made possible by advance analysis of the problem in its entirety, the direct reflection of this analysis in project design, and the negotiation of contracts for utility purchase before project completion are of paramount importance. Mechanical design is closely tied up with the outcome of utility analysis; indeed the entire project design is involved in the decisions based on this analysis. Hence this should be one of the first matters to be settled.

MECHANICAL AND ELECTRICAL DESIGN

The mechanical facilities in low-rent housing provide amenities for the tenants strongly in contrast to those of their former homes. The objective, however, is efficiency of design, durability of materials, convenience, and ease of cleaning rather than expensive, over-elaborate or unnecessary equipment.

LAWNS AND PLANTING

Attractive lawns, shrubbery and trees require a thorough knowledge of how a project operates day by day and season by season, together with skill and restraint in plant selection, arrangement and planting.

The practice of retaining good trees found on the site, together with new planting designed for long range enjoyment, has afforded great satisfaction to tenant, management and to the general public at relatively small cost.

RESPONSIBILITY OF THE ARCHITECT AND ENGINEER

A planning procedure that could contribute to the success of every project to be developed in the future is outlined in a paper issued by the Public Administration Clearing House and sponsored by the National Association of Housing Officials.[1] The report, here quoted, results from several years of direct contact with all phases of public housing design and management.

"The local authority should establish, from its own careful and detailed study of the exact purpose and ultimate function of the project and with whatever technical assistance it needs for these purposes, all of the pertinent requirements of the project and then, and only then, call on the architect and engineer for a solution to the problems as defined.

"The services to be performed by the architects and engineers who are employed by the housing authority to assist in preparation of the architectural program differ somewhat in nature from the more normal services which they perform in accordance with a contract to design and prepare plans and specifications for a particular project. This difference in type and scope of services suggests the advisability of employing architects and engineers on a consulting basis for assisting the housing authority in establishing the basic program requirements and design criteria. It is rather difficult before the scope, type, financial limitations, and other factors of a project have been outlined to write a contract for complete architectural and engineering services which will turn out to be satisfactory, either financially or otherwise, to both the authority and the architects.

"After it has rather definitely established the basic requirements of its architectural program, the housing authority should be in position to say to the architects whom it has selected to design the project, in effect:

> We propose to construct 'X' number of houses at such and such a location to accommodate families of the lowest income group who cannot afford to pay, on the average, more than 'Y' dollars per month rent. This project is a specific part of the long range housing program which we have established after careful planning. We have made a thorough study of the financial requirements of the project and of the rents which must be achieved. We have made a study of the various community functions of the project and of the type of management functions required to accomplish the full purposes of the project. We are giving you a detailed outline of all of those requirements and a description of the factors which we consider pertinent to the design of the project. We are now ready to ask you to furnish us with technical and architectural solutions to these problems and are prepared to enter into a contract with you for such services.

"Instead of starting out by making fascinating sketches, the architect can begin with a frank recognition of the economic and social problems for which he has been asked to develop a practical, technical solution and an architectural expression. He must really become a 'functionalist' in the full sense of the word. Before he draws a single line, he must be able to orient his thinking toward the critical factors in the design. He can establish his range, set his sights, and shoot directly at the target which the local housing authority has set up. It will undoubtedly take several trial shots and several readjustments, but at least he knows just what he is shooting at and just how far each try misses the mark."

---

[1] The Local Housing Authority and the Architect. Oliver C. Winston, Chicago, Public Administration Service, 1945.

Site Selection

SELECTION of a site is the first step in physical planning that is taken in the development of a slum clearance, low-rent, public housing project. The direction which this step takes may head the project toward success, partial success, or failure. The purpose is clear, but the direction is often not fully considered: There is a specific housing need to be met—slums to be cleared and under-privileged people to be decently housed. People must be given first consideration; slum clearance though more spectacular, is merely a by-product of housing under-privileged people.

> The slum of today is no longer a hot-bed of cholera and typhus fever as it was seventy-five years ago. It remains, however, one of the major obstacles to that physical and emotional and social vigor, and efficiency and satisfaction which we conceive as the health objective of the future—Research Association Report
> Occupying a large portion of the city at its very heart, decadent and obsolete dwellings and the blighted character of the neighborhood surrounding them have discouraged the development of large-scale improvements, lowered the level of living standards and provided a constant threat to city finances. — City Planning Commission Report

In order to meet this need answers to the following questions are needed: Who are to be housed? How many are going to be housed? What is their rent-paying capacity? What is their family size and composition? Where do they work? And at what? What, if any, are their special living habits: derived from national or racial origins or from other influences? The manner of gathering, sorting and evaluating such data is not the business of this review; but the application of such data guides each phase of project development, and site selection is the point at which this application begins.

It is, of course, true that most of the housing needs can be met by more than one type of site. The local housing authority may be influenced by special considerations not directly related to the needs of those to be housed and at the same time meet such needs in a satisfactory manner; such special considerations may include strong public objection to a specific slum site, public desire to rehouse through the acquisition of cheap, vacant land and to clear the slums through equivalent elimination, or some particular effect of local plans for urban redevelopment. But if the project is to be a succeess, the needs of the future tenants must be given first place.

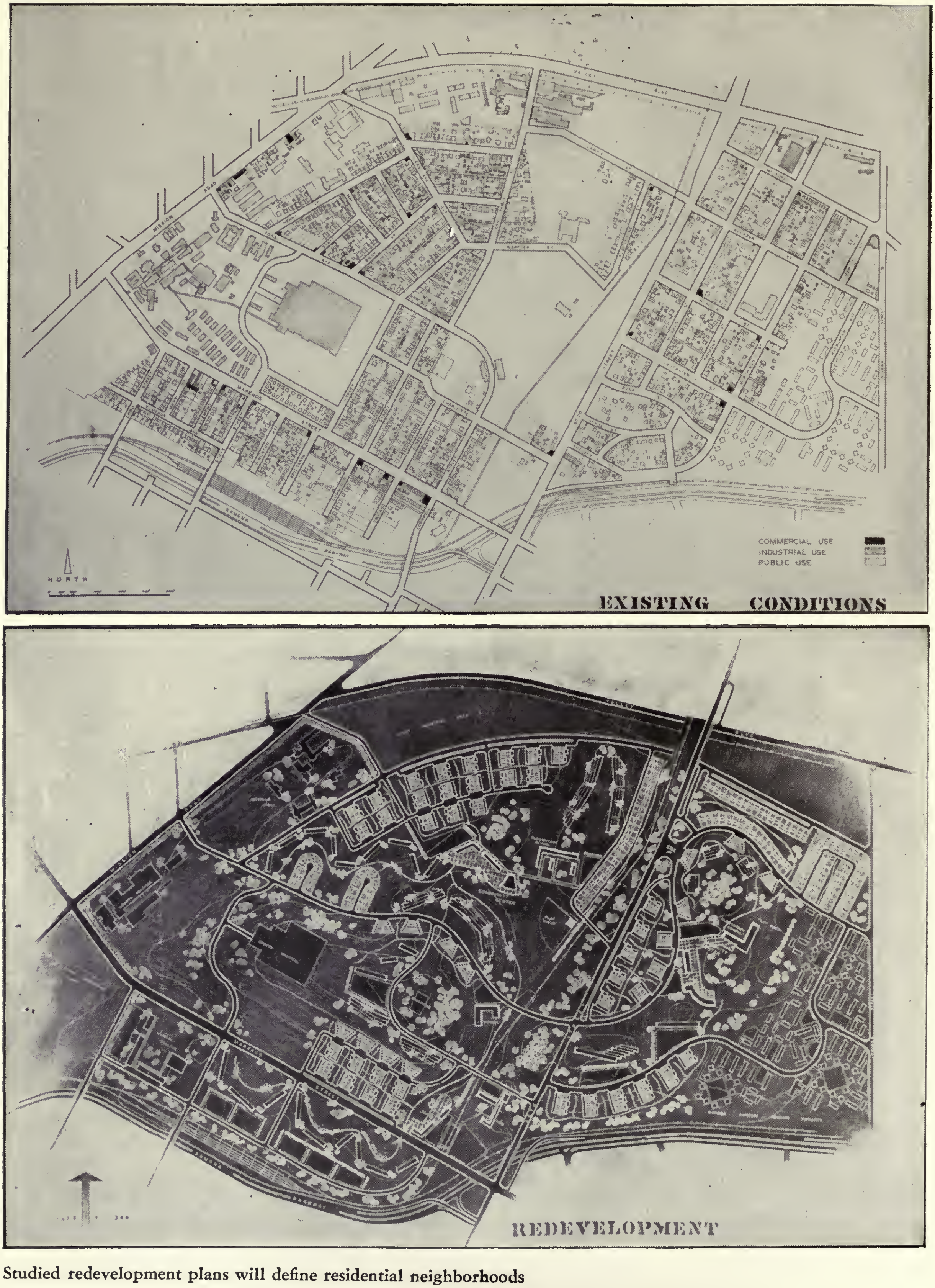
This discussion covers the more important factors in site selection. As is made clear in the "Minimum Physical Standards", a site ideal with respect to every factor probably cannot be found, and evaluation of a site must give due weight to each factor listed. Attainment of the ideal in any one respect cannot compensate for non-compliance in any other. For this reason, every factor must be investigated before a site is definitely chosen.

Finally, it should be borne in mind that all major technical decisions of design will be influenced, if not controlled, by the site—its location and environment, its shape, and its other physical characteristics. Hence the local authority and its experts advising on site selection must think not only in terms of the existing human needs to be served and of the accompanying problem of slum clearance to be solved, but also it must be alert to the planning and technical difficulties that lie ahead.

RELATION OF SITE TO LONG RANGE PLANS

The broad purposes of urban replanning in any community may be stated as: To provide for and relate dwellings to employment, commercial facilities, recreation, cultural centers, and health services; to provide convenient means of communication among all of these; and to accomplish this with regard to the continuing welfare of all the inhabitants.

It follows, then, that a properly considered city plan will lay the greatest stress upon the clearly defined and adequately serviced residential neighborhood units. Many such neighborhood units may



Studied redevelopment plans will define residential neighborhoods exist at present and may qualify for continued use just as they stand; others may need only some redefinition and adjustment. Still others, however, will be created through an entirely different use of built up areas or through the use of undeveloped land.

Obviously, as neighborhood units take their places within the replanned community, it will become apparent that they differ in the advantages and disadvantages which they offer to different people. Proximity to industrial, business, recreational, and cultural centers; the character of topographic and natural features of the area, and even the operation of often inexplicable preferences and prejudices, all will tend to indicate the suitability of each neighborhood for a more or less cohesive group, defined by economic, occupational, social or other characteristics.

Thus, if local plans are well considered, orderly and logical, there are likely to be well-founded reasons for preferring one possible site for public housing to another. The housing authority may then proceed toward site selection plans with reasonable hope that its decision will be justified.

Since the existence of well-defined and accepted studies for urban replanning would greatly simplify and support the work of the local authority in its task of site selection, we may inquire how many communities have tackled this problem and how far they have gone toward its solution. At least so much seems clear: the results of years of thought and discussion on the subject of replanning American cities will show some immediate constructive action in a large number of communities; and the consequent changes will be rather sweeping in many of these cases. It also seems reasonable to believe that the influence of what is done in even a limited number of cities will set a trend toward urban replanning that will soon be felt in practically every community.

> Future planning will reflect benefits of our several years of experience in the field of public housing and will have for its goal not only the elimination of slum-blighted areas and the providing of decent housing to families of low-income, but also the opening of new avenues for city improvement and development contingent upon the housing program. — State Report

> It is the purpose so to plan the San Fernando Valley that it will develop as a group of self-contained communities where industry and commerce will be in balance with the population, where people may live in an environment possessing all the amenities necessary for good living. — City Planning Commission Report

> In 1943, the City Planning Commission published a report outlining a co-ordinated metropolitan post-war plan, describing San Diego's situation with relation to population, financing, public buildings, highways, utilities, recreation, transportation, neighborhoods, housing. — State Report

> Richmond now has a comprehensive plan for its future development. The plan provides that each part of the community shall be located in its proper place with regard to every other part. — City Planning Commission Report

The housing authority will usually be faced with one or another of these conditions:

1. There may be a well-defined and accepted urban redevelopment plan into which public housing projects will fit readily and naturally. This is the ideal situation.
2. There may exist a defined movement toward the development of urban replanning studies and, perhaps, the acceptance of certain fundamentals which will dictate the working out of the city pattern in detail. This will guide the housing authority in its general direction, but will require alert and close co-operation with the recognized planning bodies.
3. There may be no replanning activity, but an awareness of its desirability and trends in other communities will have established at least a general guide for the future replanning. This third condition offers the most difficult challenge to the housing authority in its search for sites suitably located within the community framework.

The means by which the housing authority seeks to make its selection of a site or sites consistent with the local urban replanning situation is, of course, a matter entirely for its own determination, and the process will vary with every group of conditions. The criteria that govern site selection, if no changes are being planned systematically, will, obviously, be the same as when long range city planning is in progress, since the desirable qualities of a site discussed in the remainder of this chapter are the same in either event. The point is that where no planning changes are being considered the housing authority can only be guided by what it thinks are prevailing trends, whereas, if plans are being made—and are utilized—the authority will have the benefit of them.

Protective belts are needed between dwellings and traffic arteries

RELATION OF ZONING LAWS TO THE SITE

The "Minimum Physical Standards" require that zoning regulations, either existing or secured for the purpose, be such as to protect the residential character of the neighborhood in which the site is located. If this domestic character is lost through engulfment by business or industrial areas, the housing may continue in use as mere shelter but will cease to be a place of desirable residence and will risk following the familiar downhill route of gradual deterioration, blight, and final decay into slums.

It is dangerous to hazard the possibility of such residential decay, and, moreover, it is equally bad for business and industry, since sound reason and logical planning may dictate the ultimate location of such enterprises in these areas. This does not mean that public housing should not be in reasonable proximity to business or industry. Its very purpose may best be served, in fact, by such a relationship, provided that there are adequate protective belts of some kind between the residential areas and the objectionable features resulting from business and industrial districts, railroads and other traffic arteries.

It must be recognized that zoning does not of itself guarantee a perpetually static condition, nor, indeed, would such a condition be desirable. Zoning must adjust itself to growth and change. It can, if thoughtfully handled, operate against haphazard and chaotic intermingling of unrelated land uses. Thus to some extent it is a means of carrying out long range planning.

> Together with the master plan, zoning can bring order into the physical development and growth of the community. — Committee Report
>
> One of the major amendments was a change of a 37-acre blighted area from commercial to residence zoning, a step towards urban rehabilitation by encouragement of new residence buildings in an area not developed for the commercial and light manufacturing purposes anticipated when the zone was established twenty-three years ago. — City Report

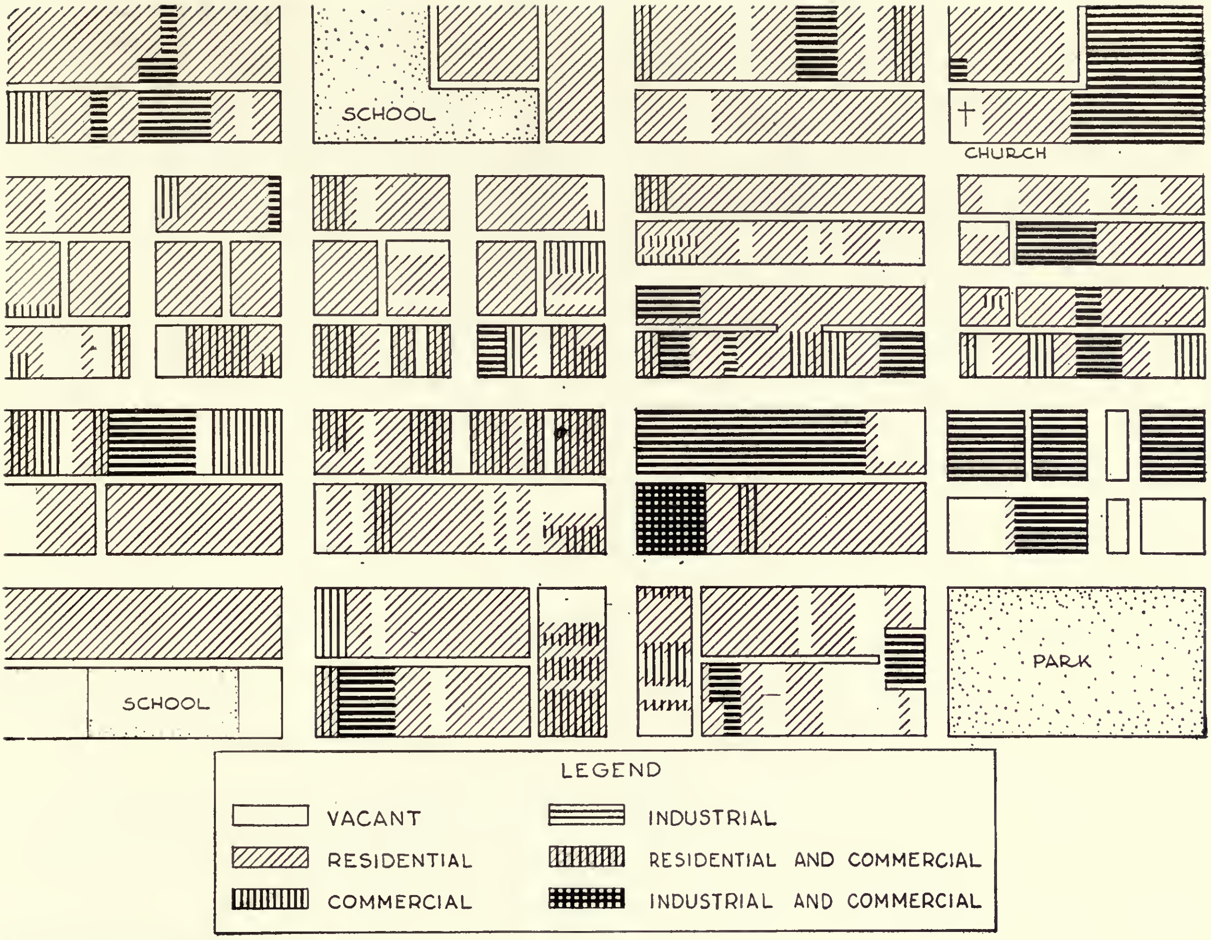
RELATION OF TRANSPORTATION AND OTHER SERVICES TO THE SITE

The requirements of the "Minimum Physical Standards" relating to these matters are those for which judgment rather than rule must find most of the answers. It is to be hoped that, with urban replanning, the location of residential neighborhood units will be well related to all of the necessary facilities: to transportation, schools, shopping and recreation, and to everything else essential to the health, safety, convenience, and general welfare of the project tenants. But as a practical matter it must be recognized that while many of the areas which the local authority may have under consideration might logically be chosen for many reasons, they will probably not be situated ideally with respect to all the necessary facilities.

The facilities and services with which the local authority is concerned at this stage and which it must consider in relation to prospective sites divide rather naturally into two broad groups (1) those which must be close to or within the site, and (2) those which must be available within reasonable distances.

The first group includes at least the following essentials:

1. Utilities, such as water, sewerage, gas, electricity.
2. Police and fire protection.
3. Garbage and waste collection.
4. Street cleaning, removal of snow, etc.



An example of hapazard land use

Such items as these are almost always provided by the municipality, but their adequacy and their availability to sites under consideration should not be taken for granted. Investigators have been misled, for example, by the presence of fire hydrants, electric power lines and sewer manholes, which do not necessarily indicate an adequate supply of water or electricity, or sufficient sewer capacity. The recommendations on utility services contained in "Site Engineering" and "Selection of Utilities" will assist the housing authority in chosing between alternative sites having different present or potential utility services.

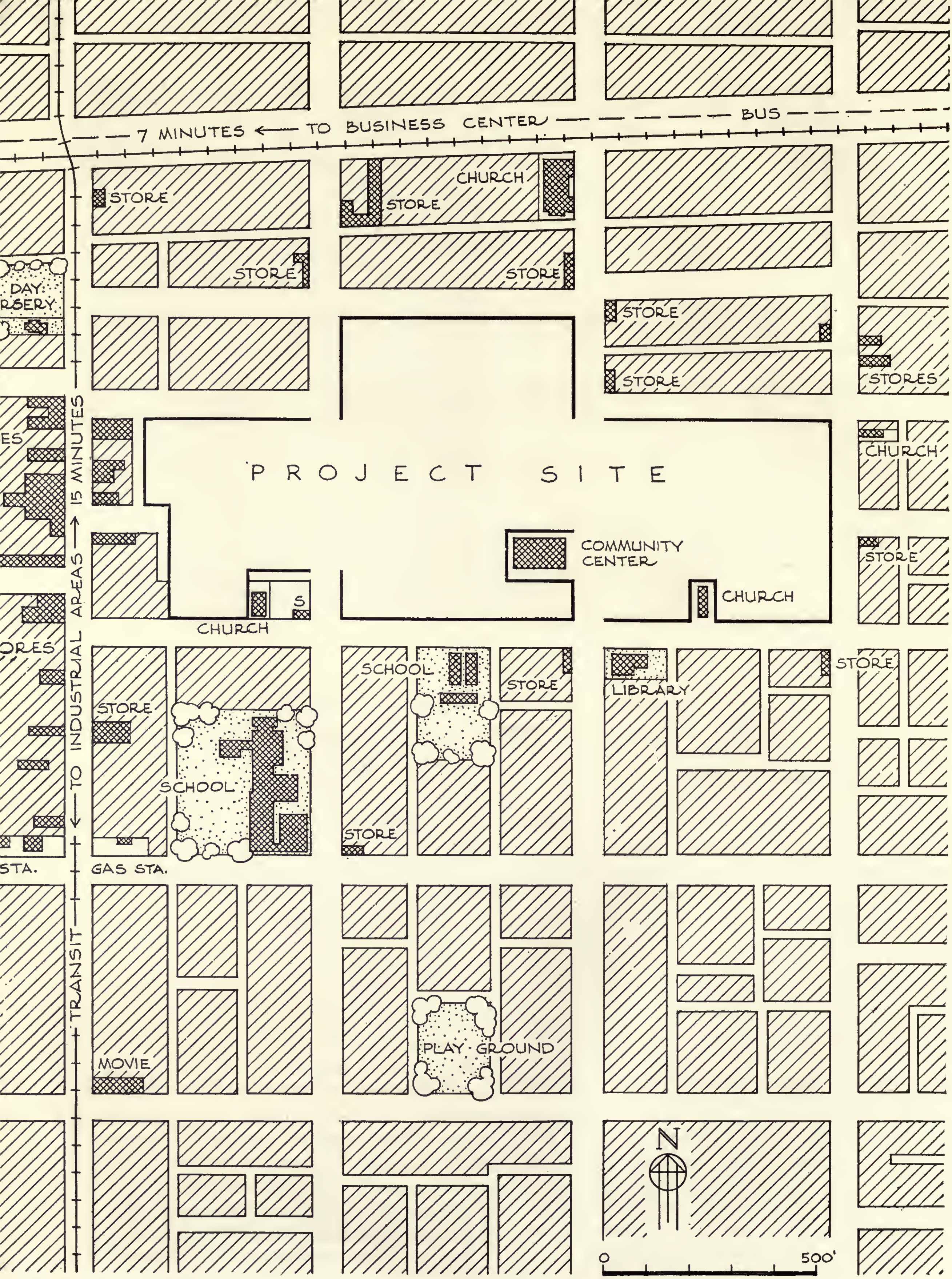
The provision of these services to specific sites, especially those in outlying areas, may involve city budgets and therefore should be carefully investigated to determine whether valid co-operation agreements can be secured before definite decisions are reached.

The second group of services and facilities includes:

1. Transportation to employment and places of business.
2. Neighborhood shopping.
3. Schools.
4. Playgrounds.
5. Churches, libraries, theaters, etc.
6. Hospitals, clinics, welfare institutions.

This group, unlike the first, involves services to which tenants must make their way; hence the criterion in each case is the time, effort, and expense required to reach the objective, none of which can be precisely established. Acceptable walking distances vary with the age of the walker, the nature of his work or errand, the prevailing weather conditions, and the topography of the area traveled.

Commercial Facilities: Should be built or existent. Any notion that private enterprise will come along



Neighborhood map showing reasonable distances from project to facilities and supply shopping or neighborhood facilities is a completely erroneous one. — FWA Report

Lack of shopping facilities felt. — Committee Report

Both projects are well integrated into the city, only fifteen minutes by bus from central business district. — FWA Report

Inconvenience in distance from home to shopping. Mothers felt disadvantage of lack of supervision of children when they had to leave home. — Washington State

Site Selection: Excellent; within radius of one mile are to be found most of the commercial, educational and cultural facilities which the city offers. — New York

While it is difficult to establish maximum distances between housing projects and the various facilities, it is possible to suggest from past experience a range of distances and of travel time by which the advantages of one site can be weighed against those of another. Such a list is reflected in the neighborhood map which illustrates the table of time and distance ranges for various facilities below.

TABLE I

REASONABLE RANGE OF DISTANCES BETWEEN PROJECT AND NECESSARY SERVICES AND FACILITIES

(Note: the distances stated below are not averages but are assumed to be those from the service or facility to the most remote dwelling unit)

Service or Facility	*Range of Distance*
Bus or trolley stop for transportation to normal places of employment, city, business center, etc.	¼ to ¾ mile, but maximum warranted only when route is paved, properly lighted, and otherwise convenient and safe.
Neighborhood shopping	¼ to ¾ mile, but ½ mile preferable as maximum.
Kindergarten and grade schools.	¼ to ½ mile, unless school bus service provided.
Junior high and high schools.	½ to 1 mile, unless public transportation available.
Playgrounds, junior	¼ to ½ mile.
Playgrounds, senior	½ to 1 mile.
Churches, moving picture theaters, libraries, and similar facilities.	Preferably ¼ to ¾ mile, unless public transportation available.
Hospitals, clinics, welfare institutions.	Within ½ hour travel time by public transportation.

HAZARDOUS CONDITIONS AND CHRONIC NUISANCES

Unfortunately it is in the very nature of a program directed toward slum clearance that complete avoidance of unpleasant and dangerous surroundings is difficult. However much this review may refer to the replanning of communities and may imply hope that through this replanning the future will produce conditions under which no unpleasant, unhealthful, or dangerous situations may ever be encountered, such conditions do exist today, and many years will pass before they are eliminated.

Smoke, fumes, odors, noise and vibrations are the principal nuisance items, and these are most likely to be caused by railroad yards, airports, heavy traffic arteries, public incinerators, refuse dumps, swamp areas, industrial shops, chemical works, and meat processing plants. Most of these sources of discomfort or injury to health are things necessary to the life of a community and, however well managed, they still will create undesirable if not harmful conditions. The problem then becomes one of determining how far removed from such a source a project must be in order to reduce the nuisance to the point where it no longer hinders decent and healthful living.

Here again no rules can substitute for sound judgment. Smoke and odors do not respect distance under certain atmospheric conditions. These, as well as noise, travel far with prevailing winds. Complete

Smoke and odors do not respect distance

Steep, unprotected banks are hazardous

avoidance of such annoyances, in some communities at least, would mean placing projects too far from normal centers of living. Probably the best that can be done by the housing authority is to make frequent observations of the proposed sites under varying weather conditions, and having reached tentative conclusions as to the frequency and severity of recognized nuisances, to check these conclusions with the local health agencies and then make the best compromise possible.

Site Selection: Bad, due to unpleasant immediate surroundings. City dump, oil refineries, chemical plant, excessive ground settlement. — Pennsylvania Slaughter pen nuisance. — Research Association Report

Hazardous conditions fall into two general categories: those which jeopardize life and limb, and those which may cause property damage. In the first group are dangers due to the proximity of railways, high-speed traffic arteries, unguarded pits or embankments, and unprotected bodies of deep water or swamp land.

The second group is more limited: the principal hazards come from the possibility of flooding, landslides and subsidence of earth over abandoned mines or reclaimed swamps. Regional dangers include hurricanes or earthquakes. These last must be met by special construction methods.

No site is safe which is subject to periodic floods, either general or of the flash type. Extremely remote possibilities of minor flooding may be met by the raising of grades, by construction of water barriers, and by improved drainage.

Railways should be separated from dwellings by barriers

Swamps, ponds and bodies of stagnant water may be breeding grounds for malarial mosquitoes. They are, with quarries, dumps, clay pits, and steep embankments, a source of danger to children; the instinctive spirit of adventure will lead boys and girls to such places. However, very young children should be and can be protected against such hazards either by suitable barriers or, better, by locating the projects where such dangers do not exist nearby.

The presence of railroads and of high-speed traffic arteries close to a project may be unavoidable in many cases, but in such instances the dangers should be minimized by planning expedients.

The dangers and nuisances which may be latent in the proximity of airports have not yet been considered in connection with public housing. Increase in air travel and the development of the autogiro and helicopter may very well bring some airfields closer to residential neighborhoods than at present; or such neighborhoods may push close to airfields. Noises and potential dangers must, nevertheless, be considered by housing authorities contemplating sites adjacent to existing or projected airports.

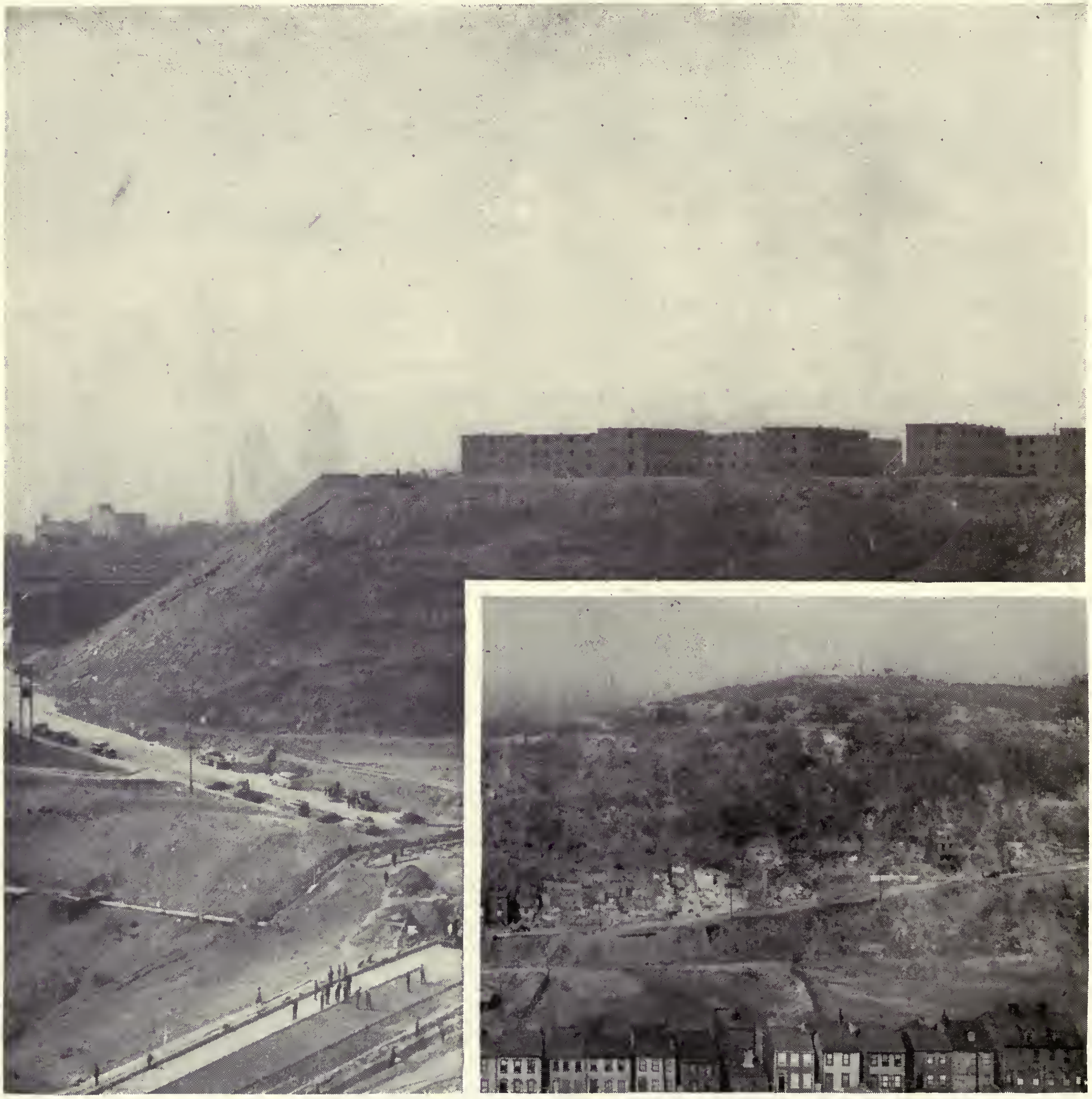
Children seek adventure in dumps and other out-of-the-way places

An airport is a source of noise and, possibly, of danger to its neighbors

Danger due to earth movement and subsidence is ordinarily best met by avoidance of such sites. There are notable exceptions; Pittsburgh's gallant adventure in slicing off the tops of its hills to create good sites is a case in point. The decision to quench burning mines and to buttress sliding earth would have alarmed a less vigorous community; but the other available city sites would have subjected occupants to smoke-filled river valleys close to shrieking mills and railway yards.

As to the mitigation of some objectionable features of sites through the manner in which the planning is handled: Physical barriers against some of these dangers may be provided; for instance, traffic hazards may be overcome by highway underpasses or overpasses, and protective belts and screens will minimize noise and smoke.

The housing authority should consider the suggestions for remedying these and other bad situations discussed elsewhere in this review, chiefly under "The Site Plan", before they reject otherwise desirable sites with some unfavorable conditions.



A hilltop is sliced off to provide a commanding site

COST OF SITE: DIRECT SLUM CLEARANCE VERSUS CLEARANCE BY EQUIVALENT ELIMINATION

The cost of a project site—probably the most serious point for consideration in connection with its selection—is the most difficult of all to discuss in precise terms, since final judgment in making the choice will be influenced by almost every other aspect of project development. If a public housing project were developed on the same basis as a private residential real estate operation, it would be concerned primarily with the purchase of suitable land at the lowest possible final cost.

Public housing has, however, as one of its first objectives the elimination of slum areas. So long as it must carry the load of present inflated values unrelated to use values, it must endeavor to find means whereby this load may be borne without undue expenditure of funds, and without creating future housing problems.

In many cases, by justifiable use of equivalent elimination, the problem may be solved satisfactorily through the purchase of inexpensive undeveloped land. By this device the cost of land per dwelling unit, even when the density of the project is extremely low, may represent but a trifling part of the total development cost. It may also eventually help to lower the cost of blighted land by a "draining" process. In other cases, however, there will be slum areas which must be attacked by direct clearance and re-use for low-rent housing; and here each dwelling unit carries a heavy load of land cost, even if the project be developed to the limits of acceptable density. Between these two extremes there may be a great variety of land types, any or all of which may be used in the elimination of slums.

In the beginning of its work the housing authority may justifiably postpone decisions which it will have to face in the end if it resorts wholly to equivalent elimination, or attacks only those slum and blighted areas which can be purchased at relatively low cost. But it will eventually have to face its most difficult problem, that of direct slum clearance in areas where the slums are worst and where the land values are inflated beyond any reasonable hope of redevelopment for profit. Proposed methods of reducing the wide spread between current market price of land and its actual use value, are still to be tried. Until such proposals become realities, the high cost of blighted land in urban centers will continue to offer housing authorities the most serious of their problems.

> It is our opinion that occupied sites should generally be used, since this is the only really effective way of eliminating slums. — Virginia
>
> The cost of acquiring and clearing slum sites, the industrial and commercial character of the surroundings and the lack of vacant dwelling accommodations to which to remove displaced families occupying the slum sites are factors which would cause the local authority to consider the selection of vacant sites. In addition to the industrial and commercial character of several slum areas, some are under flood level. — Ohio
>
> With regard to the type of sites, the experience in Baltimore to date indicates that the occupants of substandard housing within the rent market of public housing have been noticeably reluctant to apply for housing built in suburban areas. — Maryland

MULTIPLE SITES

When no single available site in a locality meets the essential needs for project development, two or more separate sites may be considered. They are classified as (1) relatively large sites or (2) "infiltration" sites. The former might be chosen because of existing utilities or public transportation when no single available site is served by these necessary facilities; the latter, which comprise vacant parcels dispersed through an improved or partly built-up community, might be chosen in order to make the fullest possible use of existing public and private improvements; utilities, streets, walks, and community facilities.

Several projects of these types were in the preliminary stages of planning when they were deferred because of the need for concentrating on war housing. On "infiltration" sites the dwellings should usually be arranged in groups without regard to platted lot lines that may be within the boundaries of the site.

Possible advantages, which multiple sites may offer, depending upon local conditions, include (1) a wide choice in site selection, (2) reduction in development costs, because of existing community facilities, utilities, pavements, and other local improvements, (3) a minimum concentration of demand on utilities, and (4) local preference (since small housing groups frequently are considered more attractive than large).

Over-crowded expensive land

Slum on a city's fringe

Slum in the heart of a city

Arrested development

Blighted neighborhood

Vacant inexpensive land

A great variety of land types may be useful in a slum clearance program

In balancing the possible advantages of multiple sites against the advantages of a single site, careful investigation of costs of site improvements and of community facilities on the multiple sites must be made to determine if they may offset possible increases in costs for (1) land acquisition and planning services, such as appraisals, surveys and technical fees, which may require more time and hence greater expense, (2) building construction, which may be higher because of dispersion, and (3) utility connections, which may exceed the cost for installations on single site projects, particularly if streets are wide.

Other considerations include (1) local public reaction to proposed dwelling types, their appearance and conformity to local regulations and (2) possible increased management and maintenance costs.

> Experience has shown that the cost per unit to operate a small project is greater than a large project. — Texas
>
> The authority desires to further its slum clearance program and it is thought that this could be accomplished at a lower cost and to better advantage by securing scattered sites. — Montana
>
> Most of the substandard housing in the county is located in areas that contain standard and substandard houses side by side. In order to prevent the spread of blight and to rehabilitate such areas, the construction of low-rent houses on scattered sites will be necessary. — Washington State

AREA REQUIRED

A number of housing authorities have fallen into the error of selecting either sites so large that each dwelling unit was forced to bear a disproportionate share of excess land cost, or sites too small for the number of dwellings desired. Such errors result from failure to consider all of the significant factors in their balanced relationship, as listed below.

1. Number of dwelling units (usually predetermined in order to take care of a specific segment of the housing market).
2. Dwelling type and number of stories (dependent upon the general location of the project, and the special needs and characteristics of the expected tenants, and influenced, to some degree, by the sites tentatively selected or under consideration).
3. Density (usually—and desirably—dictated chiefly by the type of dwelling unit selected and the number of stories).

The area of the site should be the result of the preceding factors.

Note: Suggestions for determining the range of acceptable densities appropriate to different dwelling types will be found in "The Dwelling Type: Project Density".

There are two approaches to this problem: the first, as outlined above, starts with a predetermined number of units of a desired type which imposes the approximate density, and the result is the area required.

If the process is reversed, and a given area is selected on which to plan desired types at an approximated density, the result will be the number of units that can be planned for. It is, as a rule, safer to follow the first method, since the second may not result in meeting the need for dwellings, and so, in the end, density may be increased above that first approximated.

Costs enter into all of these considerations, naturally; but it must be assumed that by the time the area to be purchased is ready for determination the whole question of land and other costs will have been at least tentatively agreed upon, and that the authority will limit its search for sites to areas where land costs are within the general price range so determined.

SHAPE OF SITE

Usually a compact area is preferable. Long narrow sites have advantages in some situations, such as along a park, steep slope or other features assuring good light and views. A square block surrounded by streets often gives the prospect of a good density, but small blocks sometimes work out uneconomically in the spacing of buildings. Sharp angles are almost always inconvenient as well as wasteful of space—but this may not be true of an apartment layout.

"Exceptions" are parcels (usually including buildings) not purchased because of their high cost. If a considerable saving in the per-dwelling-unit cost of the site can be made by not buying them, and if it is possible to manipulate the site plan around them so as to produce an acceptable project, they are not detrimental. Cut-in exceptions, however, almost always waste ground area and reduce density. If the excepted parcel is built on, it may be possible to purchase or condemn it at a reasonable price later when the buildings have depreciated in value.

BOUNDARIES

Favorable neighbors are parks, institutions, unbuildable terrain, or other areas that tend to reduce noise, smoke, street traffic, and population density, or which open up pleasant views or offer the tenants easy access to recreation. Buffer boundaries of this kind are an advantage for part of the perimeter since they reduce traffic through the project. Adequate street frontage, so disposed as to permit a convenient layout, is necessary. Proximity to well paved traffic routes is desirable, but direct frontage on a main traffic street is not an advantage; if it is unavoidable, a protection strip should be provided and the number of project drive connections with the main street should be kept down: preferably all access should be from secondary streets.

GENERAL EFFECT OF TOPOGRAPHY AND OF SOIL CONDITIONS

Topography affects both site improvement costs and livability. Steep slopes usually increase costs and make convenient land use difficult. But slopes may provide views, light, air circulation, and pleasing appearance. Southerly or easterly slopes usually are preferred. In northern states a northerly slope should be rejected if possible. Again, the definition of a steep slope varies in different cities: Slopes that are considered buildable in a city located on steep hills would not be so considered in predominantly level regions.

Land which is nearly level also presents difficulties—soil drainage, surface drainage, storm and sanitary sewers—especially when there is no nearby low area to facilitate outfall. Filling large areas is costly and may require deep foundations if the fill exceeds frost depth.

> Greater care will be exercised in choosing sites where the topographical conditions will not require expensive grading. — Pennsylvania
>
> We prefer to use a slightly rolling site as we feel that a more level site can be maintained at a cheaper cost than a hillside site. — South Carolina

Old earth fills may be buildable at moderate additional cost. See "Foundations" in "The Structure". Dumps are usually unbuildable but if they are old, or consist mainly of ashes, they make good playgrounds or parks. (Trees, if watered until established, grow well on fills and dumps.)

EFFECT OF ADVERSE TOPOGRAPHICAL AND SUBSURFACE CONDITIONS

Under a slum clearance program it may be necessary on occasion to acquire sites which are handicapped by adverse topographic and subsurface conditions. It is strongly urged, however, that such sites be avoided so far as is consistent with the purposes of a total local program, and that it should be an inflexible rule that the housing authority in making its preliminary survey of available sites (1) consider the visible physical conditions and (2) get information as to the probable subsurface conditions. Ordinarily, this investigation will consist merely of a careful engineering inspection of the sites, and possibly of a few test borings to ascertain whether there are latent conditions which would add to construction costs.

> Future projects should be built on slum-cleared areas. Projects should not be adjacent to dumps, should not be built where there are poor subsoil conditions. — Regional Report

Before final steps toward acquisition are undertaken, accurate information as to both surface and subsurface conditions must be secured. The subsurface investigation should be carried out under expert supervision, and should include the examination of old records and of neighboring buildings, and thereafter whatever exploratory work the case warrants, such as more extensive borings, test pit

Hillside sites may prove expensive

Air maps are useful as work material

excavations, soil bearing tests or the driving of test piles. If this work shows that the site was once swamp land or used as a dump, that there is danger of slides or subsidence, or that the surface is closely underlaid with rock or water-bearing sand, the land should not be acquired unless investigation shows it to be suitable for project development, and that the probable additional construction cost resulting from the unfavorable conditions is justified.

WORK MATERIAL FOR SITE SELECTION

The comparison of sites is facilitated if detailed and correct information concerning all sites under consideration is recorded on maps. Most commercial city maps are badly printed, out of date and inaccurate; rarely do they distinguish between improved and "paper" streets. City, engineering, planning offices and drainage commissions, usually have reliable maps which may be reproduced. City planning, zoning, park, and school authorities have specialized maps or information which may readily be entered on other maps. A land use map, if available, is always helpful. To this or other comprehensive map, may be added the existing pattern of racial occupancy, if pertinent. Utility companies and sewer departments often have good maps in small sheet form, showing their distribution systems.

Air maps are exceedingly useful. Large areas have been mapped for the federal government. Special air surveys, such as studies of school locations, have been made for many cities. These are all of value, even if not recent, if they are corrected by inspection or by comparison with up-to-date maps. Prints from negatives, or enlargements, are satisfactory for individual sites. Two hundred scale is recommended.

The best tools for recording information concerning sites under consideration are sketch maps at uniform scale. Much of the material for these maps can be assembled from county surveyors', recorders', and underwriters' maps and title deed descriptions; all information derived from other sources, as from air and topographic maps and utility surveys, may also be assembled on these sketch maps. Such maps are useful to engineers or consultants who may visit the sites, for surveying contracts, or for marking off buildable areas and sketching site studies in order to calculate densities.

AIDS TO SITE SELECTION

A few more or less mechanical methods for assisting the work of site selection have been devised. Rating forms giving numerical weights to various factors exist, and one of these was used to a limited extent during the war housing program of FPHA. Other attempts have been made to devise means for an economic analysis of site factors giving dollar values to each of them. These methods have not been given sufficiently extensive tests, however, to be included in this review of experience. It is hoped that local housing authorities will make available any future experience along these lines. Such methods for evaluating sites should be used only to supplement careful technical analyses, since they cannot serve as a substitute for correct judgment.

The following check list, which includes points ordinarily considered, is offered to local housing authorities as a means to assure consideration of all of the important factors.

TABLE II

CHECK LIST FOR EXAMINATION AND COMPARISON OF SITES FOR PUBLIC HOUSING PROJECTS

I. Conformance with urban pattern

1. Conformance with accepted urban development plans, or tentative plans, or probable trends in land use.
2. Present zoning; possible changes.
3. Approval of city planning bodies.
4. Possibility of closing existing streets, dedicating new streets.
5. Effect of building codes and possibility of modification.

II. Slum clearance considerations

1. Number, character and condition of existing buildings on site.
2. Number of families housed at present.
3. Relocation of present residents.
4. Equivalent elimination.

III. Characteristics of site and environment

1. Area of site compared with area needed for buildings and project facilities.
2. Shape of site; parcels necessarily excluded; deed restrictions; easements.
3. Topography as it affects livability of the site plan; favorable features such as existing shade trees, pleasing outlook, desirable slopes.
4. Quality of neighborhood: Extent of non-residential land use; suitability of neighborhood for dwelling type desired.
5. Effect of project on neighborhood.
6. Hazards: Possibility of flooding, slides or subsidence. Proximity to railroads, high-speed trafficways, high embankments, unprotected bodies of water; presence of insect or rodent breeding places; or high groundwater level which might cause dampness in building.
7. Nuisances: Nearness to industrial plants, railroads, switchyards, heavy-traffic streets, airports, etc., causing noise, smoke, dust, odor, vibrations.

IV. Availability of special municipal services

1. Garbage and rubbish collection.
2. Fire protection as affected by site location and street access.
3. Streets: lighting, cleaning, maintenance, snow removal, tree planting and maintenance, etc.
4. Police protection and other municipal services.

V. Civic and community facilities

1. Public transportation facilities: Means, routes, adequacy and expense of transportation to employment, schools, central business district, etc.
2. Accessibility to paved thoroughfares.
3. Amount and character of employment within walking distance and within reasonable travel radius.
4. Stores and markets: Kinds and locations; need for additional facilities as part of project development.
5. Schools—grade, junior high and high: Locations, capacities, adequacy; probability of enlargement, if needed.
6. Parks and playgrounds: Locations, facilities provided, adequacy, maintenance and supervision supplied; possible additions.
7. Churches, theaters, clinics.

VI. Appropriateness of project design to site, with reference to livability

1. Type or types of dwellings.
2. Project density.
3. Utility selection.

VII. Elements of project development cost

1. Land costs, including site acquisition, expense, and unpaid special assessments.
2. Effect of soil conditions, topographic features, project density appropriate to the neighborhood, availability of utilities, extent of existing street improvements, recreational facilities, and additions to be provided by municipality or utility companies, etc.
3. Building types, utility selection, site conditions, and requirements for non-dwelling structures.

VIII. Project maintenance and operating costs

1. Differences in costs of utilities appropriate to the respective sites.
2. Differentials in grounds maintenance costs due to topography.
3. Differences in estimated payments in lieu of taxes.

The Site Plan

THIS chapter is based on the knowledge accumulated from the constant study of a large number of projects, many occupied over a period of five to ten years. There are no general rules by which the merits of the various elements of the site plan can be weighed. Each plan must be evaluated individually with a full knowledge of its specific limiting conditions, because variations in the site and in other local conditions have more fundamental effect upon site plans than they have upon other phases of project design. Many illustrations of specific cases of satisfactory or unsatisfactory solutions of this or that problem, however, are offered. It is for the site planner to use his best judgment as to their application to the planning of a particular project.

SITE PLANNING DEFINED

Site planning is a broad term which embraces: selection of sites; location of buildings in functional relation to each other, to the shape and topography of the site, and to the environment; provision within the site of suitable circulation routes well related to existing or proposed streets and walks; determination of land use to complement the buildings, such as private yards, parking space and recreation areas. These, and many other things are included within the scope of site planning.

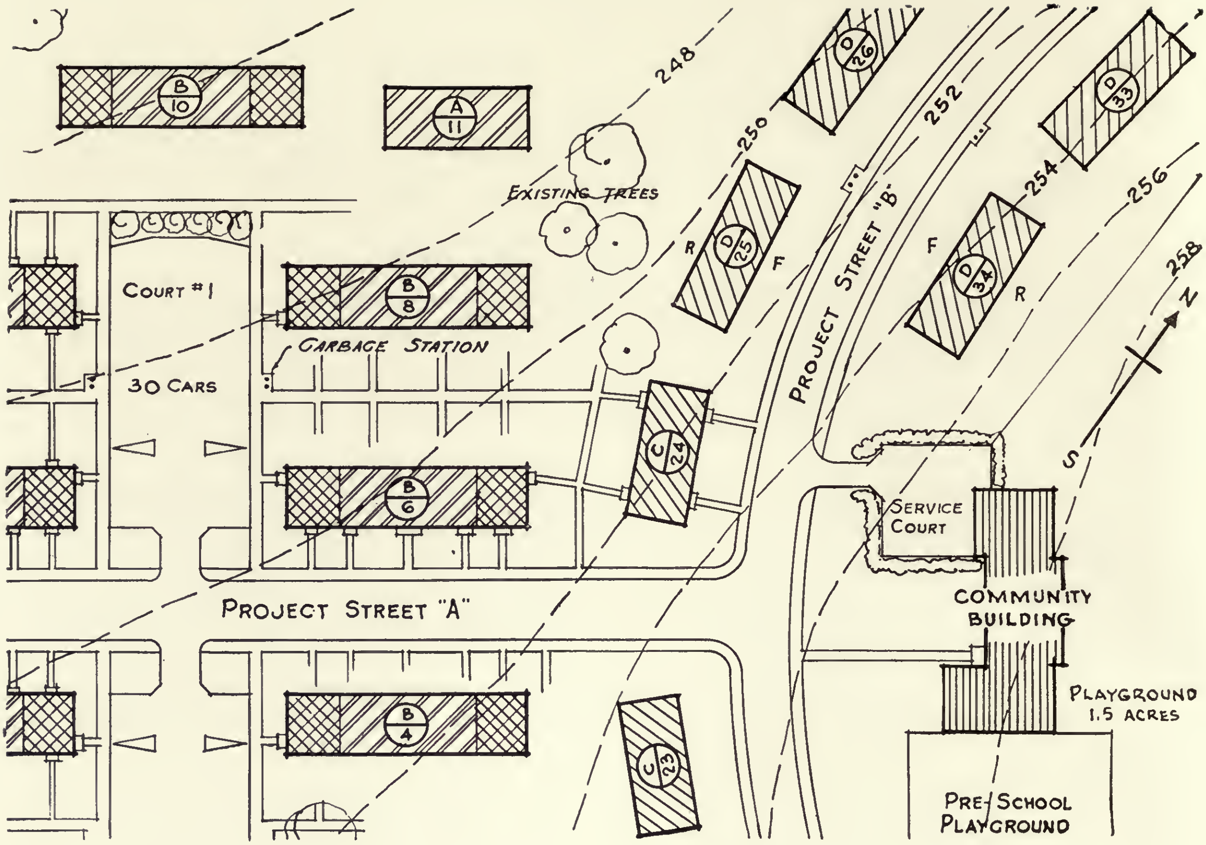
There has been at least some evidence that, in the mind of inexperienced or thoughtless designers, the site plan is looked upon as the arrangement of a group of buildings into a pattern, pleasing in its two-dimensional qualities, or as a simple scattering of buildings. In either case a few details only, such as the relationship of existing topography, street grades, and sewer depths seem to have been considered as complicating features.

The site plan is a complex thing and any underestimate of its importance risks the success of a project. The site plan is shaped by climate, by local housing customs, economic conditions and laws; by the location of the site with respect to employment, transportation, utilities, and social institutions; by the cost of the land, the relative cost of various forms of construction and the cost of utilities and maintenance; by the habits, incomes and composition of the families to be housed. It is influenced by the area, shape and topography of the site; the number of dwelling units proposed and whether these are to be apartments, flats, row or twin houses; the orientation and spacing of the buildings; the method of waste collection and disposal; and the landscape development and the preservation of existing trees. All of these factors must be correlated to produce a simple, livable, economical pattern of land use in which the land and buildings are integrated and so organized as to serve the needs of the families to be housed. The organization of the plan, if satisfactory, will also harmonize, not conflict, with the character of the land.

PRELIMINARY PROCEDURE IN PLANNING

Since site planning is so broad in its scope and so detailed in its ramifications, only a skillful and experienced planner should design the site. He can not meet the problem in haste, with incomplete or inaccurate information, or without the co-ordinated effort of all the technicians concerned. The success of a project is just as dependent upon a good site plan as it is upon good dwelling unit or site engineering plans. The latter, while serving, rather than controlling, site planning, are equally important. Experience has proved that all phases of project design must be correlated to serve best the ultimate goal of low-rent housing.

A sound approach to planning the site must start with a firm knowledge of the elements inherent in low-rent housing and with the proper working tools, that is, accurate site data. Plans have failed to attain their best possibilities because preliminary sketches



SCHEDULE								
BUILDINGS				DISTRIBUTION			TOTALS	
TYPE	COMPOSITION & SIZE	STORIES	Nº BLDGS	3 RMS.	4½ RMS.	5½ RMS.	ROOMS	D.U.'S.
A	62'-0" 4½ 4½ 4½ 4½ 26'-0"	2	10	—	40	—	180	40
B	104'-0" 3/3 4½ 4½ 4½ 4½ 3/3 26'-0"	2	8	32	32	—	240	64
C	58'-0" 4½ 4½ 26'-0"	1	23	—	46	—	207	46
D	70'-0" 5½ 5½ 26'-0"	1	25	—	—	50	275	50
TOTALS			66	32	118	50	902	200
PERCENTAGES				16%	59%	25%		100%
D.U'S. IN 2 STORY ROWS & FLATS = 104 = 52%; IN 1 STORY TWINS = 96 = 48%								
ROOM RATIO = 4.51	NET DENSITY = 16			COVERAGE = 17.9%				
AREA OF PROJECT PROPERTY = 17.0 AC.				ASSUMED NET AREA = 13.9 AC.				

PROJECT
NUMBER

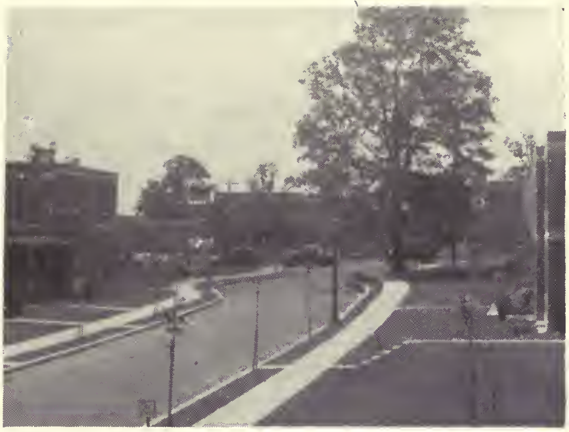
NAME OF CITY
200 D.U.
PRELIMINARY SITE PLAN

TITLE OF LOCAL AUTHORITY,
NAMES OF DESIGNERS, ETC.

SCALE DATE
0' 100' 200'

Site plans—from preliminary studies through the final plans—should clearly show essential data about the site, dwelling types, and building composition became crystallized before the fundamental problems were clarified or because incorrect or misleading information about the site was used. These preliminary steps are, therefore, suggested:

1. Site planning should start with and continue to be influenced by the best obtainable information relative to the prospective tenants, their economic status, their basic requirements, and their legitimate desires.
2. The general method of project management and maintenance, and plans for providing community recreation and welfare services should be formulated early, even if very tentatively, since they will influence the plan.
3. The approximate number of dwelling units, their distribution by size, and the dwelling types should be determined before the site plan is started. The unit plans and the plans for management, maintenance, and community activity buildings should be available in sketch form. All phases of project design may then be carefully programmed and, as the need arises for adjustments in the site or building or other project plans, correlation of all design work can readily be achieved.
4. Complete information should be obtained on all municipal services, such as water, sewerage, street illumination, waste disposal, and police and fire protection.
5. The probable combination of utilities for heat, light and cooking should be known. This should be crystallized into final form at the earliest possible moment, since the entire project design may change materially with minor shifts in utility schemes.
6. While the very first and most of the early studies can be made from sketchy survey material and familiarity with the site, accurate information should be obtained before lack of data causes damage, which even at an early stage may prove to be very costly if not almost irreparable. Subsurface as well as surface conditions are as important to the site plan as to the building plans.
7. An early contact and working arrangement should be made with the authorized city planning body, even though such steps as may have been taken toward urban replanning are quite limited. The site plan should be in harmony with any plans for future development which have been recognized and accepted, or so far as possible, with indicated trends where no plans are yet agreed upon.



Inaccurate preliminary data resulted in awkward shift in road alignment to save existing tree

Organization of the Plan

"ORGANIZATION" DEFINED

This convenient term, used in reviewing and discussing site plans, is not easy to define with precision. In its broadest sense it means the practical and esthetic coherence of the whole layout; but it also includes the detailed scheme that makes the project work. Site plans, in other words, are organized in two degrees—as a whole, so that the project will operate smoothly and will express visually its unity and good order, at the same time taking its place as part of the community; and in detail, that is, as a texture of building arrangement and servicing, so that each dwelling unit will function smoothly.

Each major consideration in the design (and most minor ones, as well) takes its place in the organization of the site plan and must play its proper part if the objectives are to be met. These considerations are outlined at this point, partly to provide a preliminary check list and partly to emphasize the scope of the problem:

1. General type of project: whether it shall be planned as a superblock or shall follow existing patterns of subdivisions and streets; and, beyond that point, whether it should be designed as a perimeter plan, or an open plan, or otherwise.
2. Arrangement of dwelling buildings: in relation to one another, to city and project streets, to the

topography, to sunlight and prevailing breezes, to the scheme of land use.

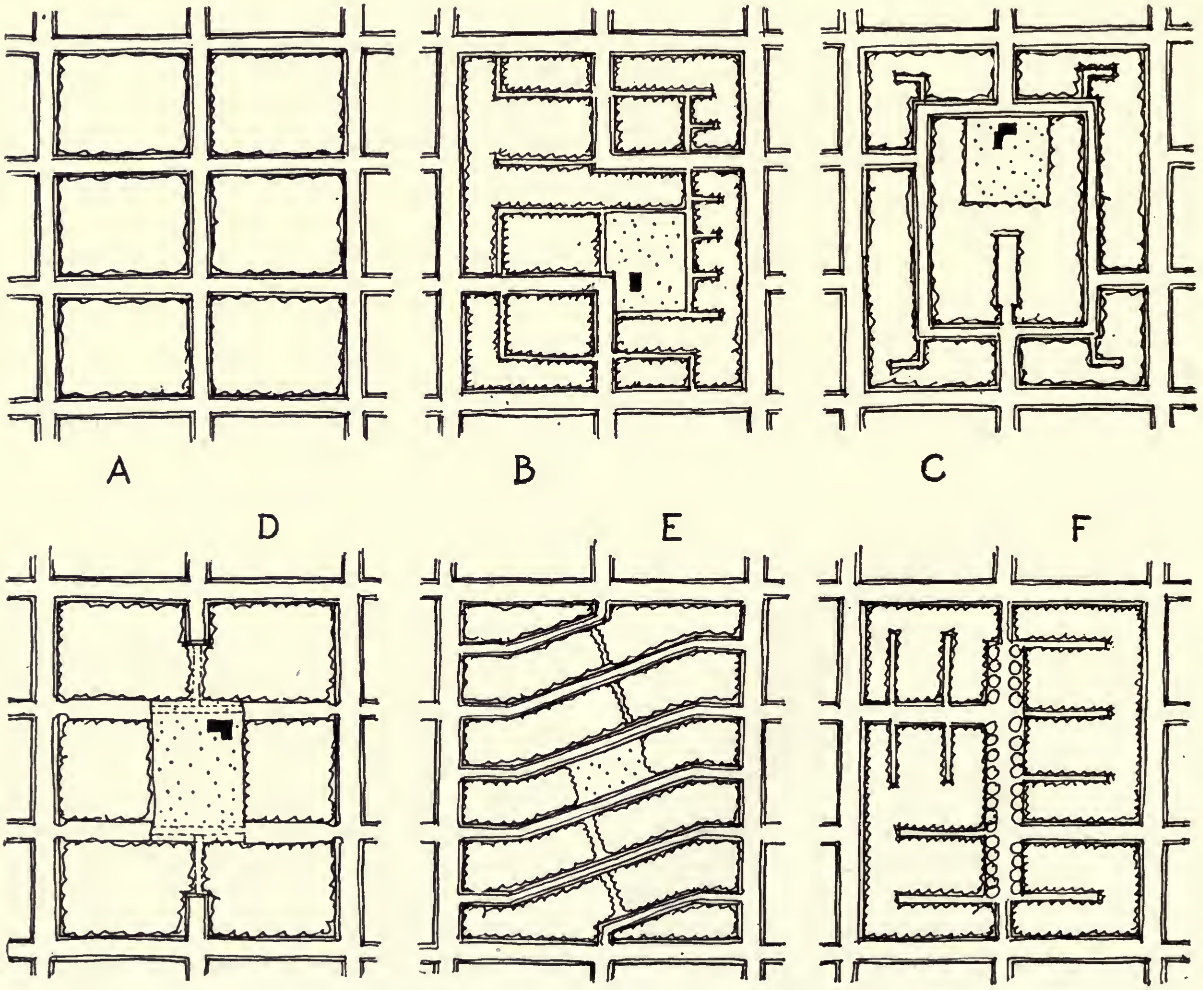
3. Location and arrangement of administration and community activity buildings: in relation to one another, to circulation routes, to the topography, to orientation, to the outdoor recreation areas and to the dwelling buildings.
4. Circulation and access: by means of streets, drives and walks; parking spaces.
5. Service arrangements: waste collection and removal; fuel delivery; fences; street lighting.
6. Land use: for tenant yards, allotment gardens, laundry yards (private or common), recreation areas, and for other purposes.

All of the foregoing items, and others, are discussed in the remainder of this chapter and some of the more salient points to strive for—or to guard against—are noted under each heading.

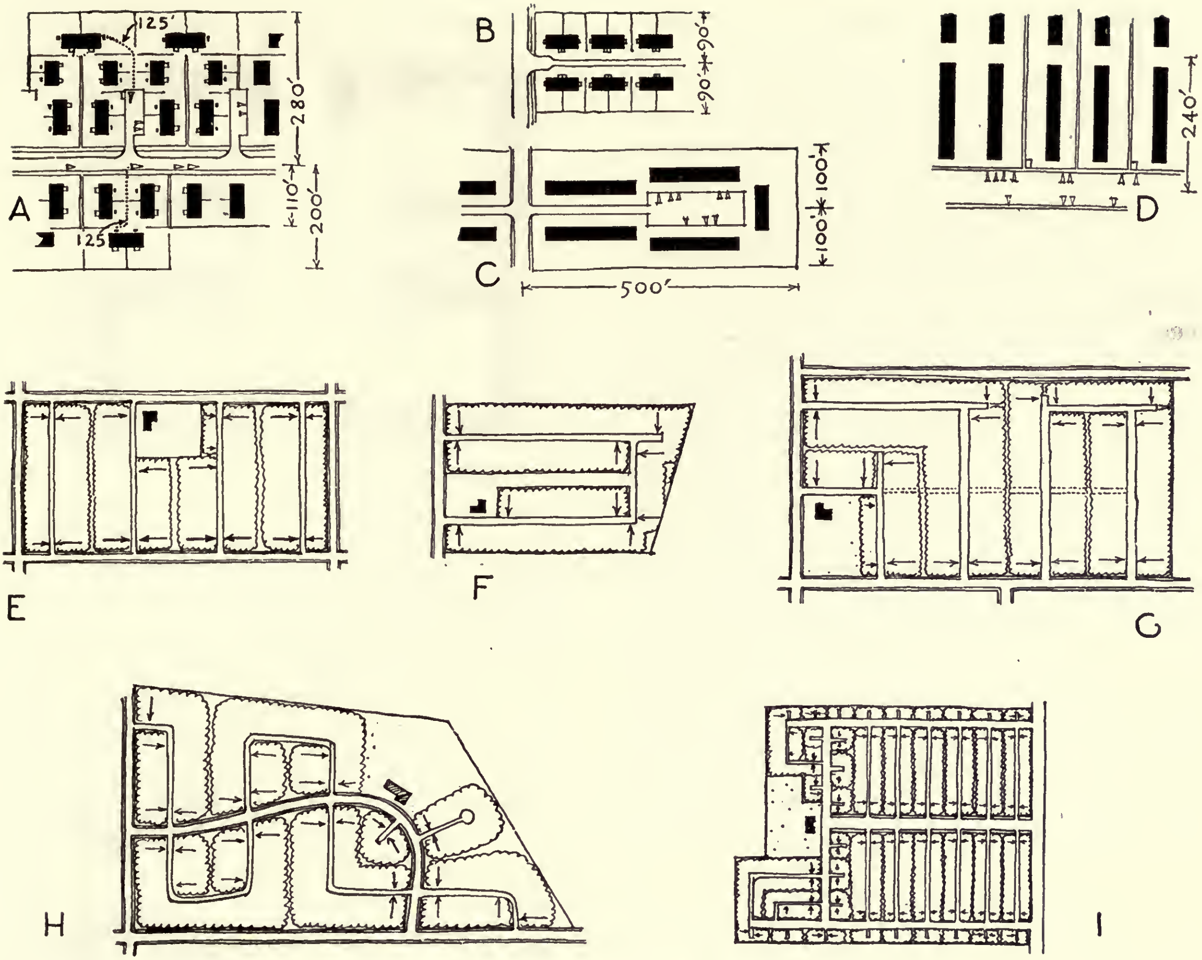
THE SUPERBLOCK

The great majority of public housing projects, to date, have been planned upon the superblock principle. A superblock is a relatively large residential area bounded, in part at least, by through traffic streets but free from such traffic within its boundaries. Cul-de-sac or dead-end streets may be used to give internal access; or through streets, reduced in width or placed to slow or discourage all but local traffic, may be used to serve the project. Many varieties of the superblock are possible, and it often may be used as the basis for organizing the plan.

The great advantages to the inhabitants of a project through such arrangements are readily apparent: it would not do, however, to deny that in theory, at least, the blocking of through traffic in one large area must increase it in others—to their corresponding disadvantage. This raises a nice point



Many varieties of the superblock are possible within existing gridiron street systems



Examples of service strips and how they are organized into a project plan

in city planning, not to be debated here, but worthy of consideration, and underlining the necessity for close cooperation with local planning bodies when projects are being planned.

TEXTURE OF THE PLAN

The texture of a project is a term used to denote its unity or its variety of basic plan-units. These, often called service strips, are patches of plan, each comprising a reasonable proportion of the total number of dwelling units, which meet the basic requirements for utility and other services and of access, and which conform to the predetermined concepts of density, coverage and building spacing. As a starting point in site planning and with these plan-units in mind, the site as a whole is studied with regard to a circulation system meeting the conditions of the site and permitting the service strips to be placed in the plan in good relation to all of the factors inherent in the problem. At the same time the project center, that is, the administrative and community activity buildings and usually the principal recreation areas, are fitted into the most advantageous positions.

Most plans are based on a single texture, that is, on the repetition of a single service strip or plan-unit; others, because of the use of varied building types requiring differences in servicing, employ more than one texture. A few plans strive for texture variations as a means of obtaining increased interest, but the wisdom of such planning is questionable. At any rate, there is no doubt as to the economy of uniform housing texture, both in operation and in construction costs.

Texture, as the term is used above, is largely a matter of two dimensions; as such it is invaluable in judging satisfactory functioning of the project. Texture becomes a controlling factor in appearance when the third dimension is applied to it. It is highly useful, therefore, to check the scheme at an early stage by means of scale models, however crude these may be.

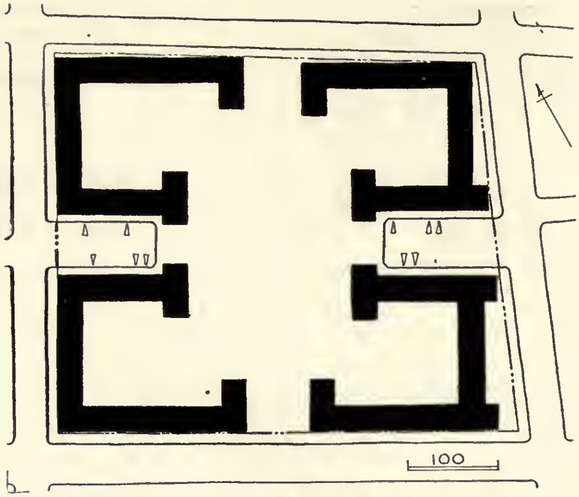
Arrangement of Dwelling Buildings

BUILDINGS IN RELATION TO CITY AND PROJECT STREETS

There is a current tendency to avoid what has heretofore been customary, namely to face the dwelling upon the street so as to present its pleasant aspects to public view and to screen what generally have been its less tidy and more unattractive elements. This tendency often influences the site plans of public housing projects, but there are also buildings which present their ends to the streets, affording an unrestricted public view into rear yards but giving to their tenants the largest degree of freedom from traffic noise and dangers; buildings which frankly turn their rears to the street so that their fronts look on interior open spaces; and all manner of other unconventional arrangements. The practical aspects of the problem are closely related to the points noted below.

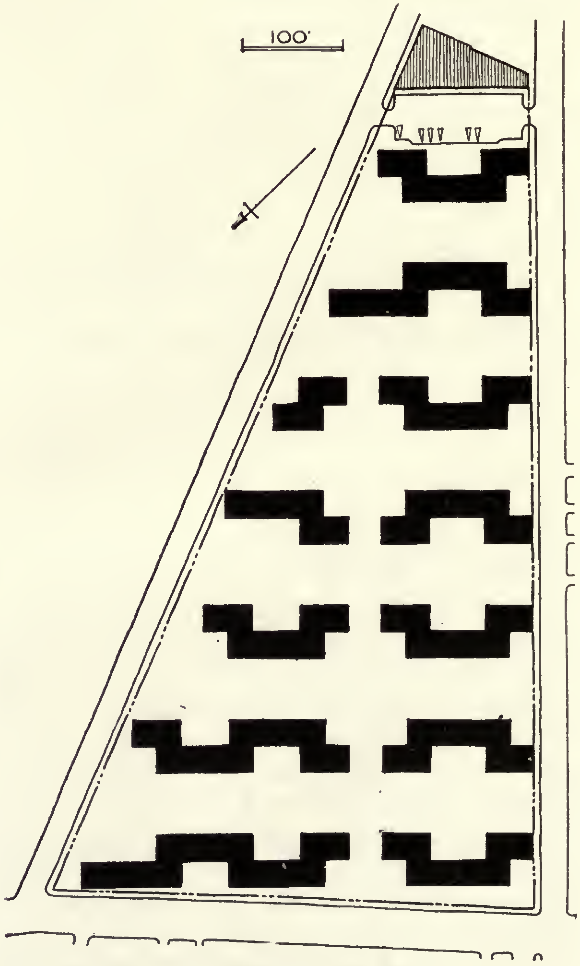
Perimeter Plans. Normally streets are wide spaces and afford as much light and air and nearly as much privacy as any other space of equal width. In crowded projects it may be better to take advantage of this space by facing the buildings directly upon the streets rather than by forcing limited spacings within the project.

Rear yards are occasionally screened with garden walls

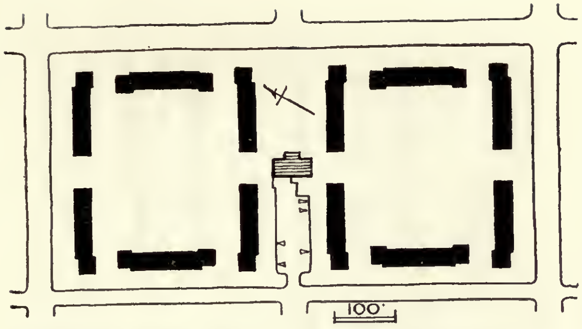


A closed perimeter plan for three-story apartments

Apartment House Projects. The closed perimeter plan has definite advantages, social and esthetic, but these are largely negated unless the entrances



An open plan for three-story apartments

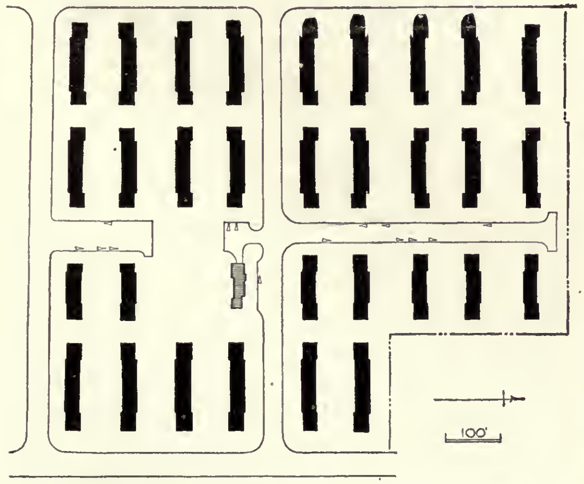


A closed perimeter plan for two-story row houses

open on the large interior spaces. The open plan provides open vistas which may be enjoyed by the public as well as the tenants, and fewer of the apartments face directly upon streets.

Row and Twin-house Projects. On public streets, the end-to-street relation has generally provided tenant satisfaction and little unfavorable public reaction. Where this plan is not feasible, fronts usually are presented to streets unless there are obvious advantages in the rear-to-street arrangement.

Along project streets wide enough for parking, the end-to-street system has usually been the most satisfactory, though considerations of orientation and topography may render this impracticable. In a small project the rear-to-street arrangement may be unobjectionable, but in a large one it is well not to use this system along all of the boundary or main circulation streets. In any event, the nature of the heating, and of other facilities and services, will have a bearing upon the arrangement.



End-to-street relation has generally provided tenant satisfaction

Setbacks from Boundary Streets. Where traffic is heavy, a setback of twenty or thirty feet from property lines has proved desirable—ten or fifteen feet for minor streets. These widths should be materially increased along main highways, and the possibility of future street widening should not be overlooked.

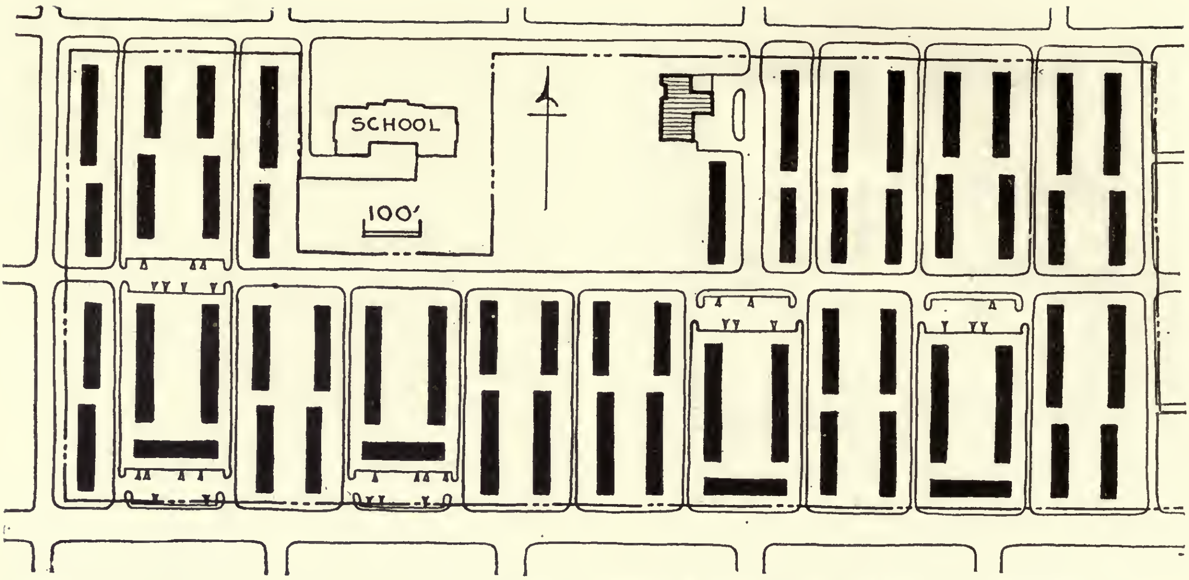
Setbacks from Project Drives. This is controlled by building spacing and distances for coal delivery. When buildings face project drives, a setback of twenty feet from the curb is desirable; eight feet from the walk is a normal minimum. Ends of buildings may stand somewhat closer. At the rear, the range is fifteen to thirty feet.

RELATION OF BUILDINGS TO EACH OTHER

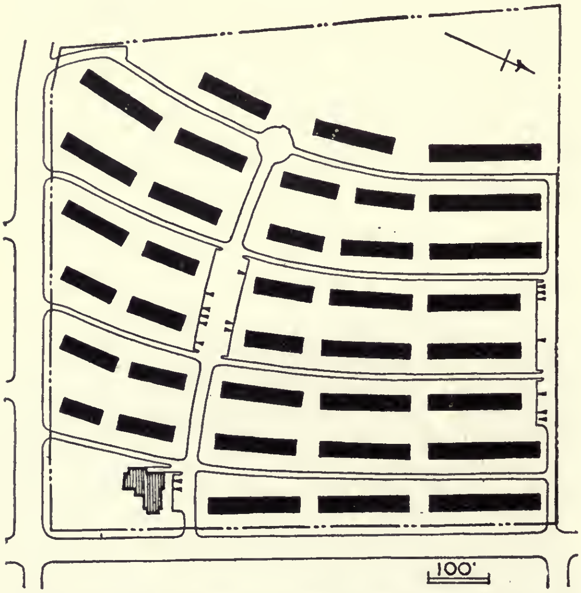
The relative position of buildings is influenced by topography, orientation, appearance, provision of amenities, and by economy in initial and operating costs. The general types of building arrangement which have usually occurred may be roughly classified as:

Straight and Curved Rows. Straight rows are easily related to existing straight streets; they provide uniform orientation, facilitate service and economical utility layout, and have the quality of good order. Curved rows, while not always an affectation

A curved street justified by topography



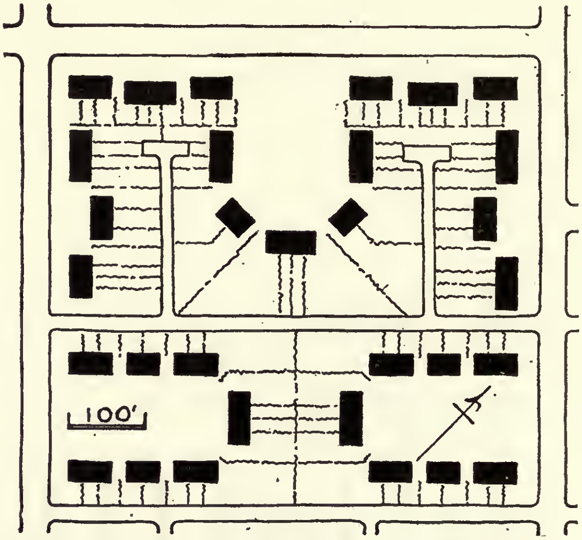
Straight rows are most common; generally they are more economical than curved rows or court patterns



Curved rows are logical when reflecting grade conditions

on level sites, are more logical when reflecting grade conditions.

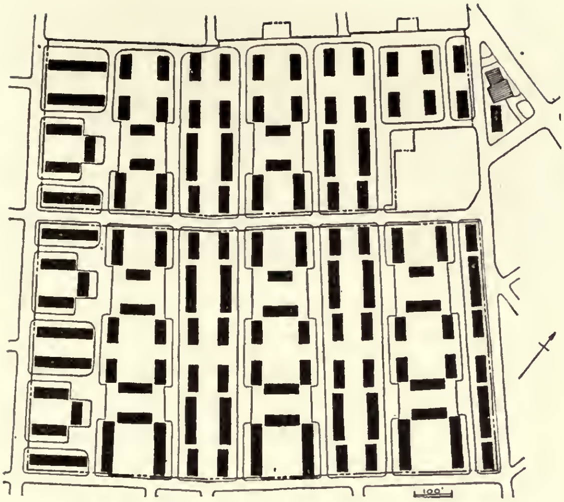
Court Plans. Court plans use buildings in perpendicular relation, commonly in "U" formation: this has visual appeal through unity, and advantages in the pooling of open space. The disadvantages are: inconvenience of circulation and inefficiency of service drives; difficult use of land at exterior corners; high development and maintenance costs; and awkwardness in relation to sloping ground.



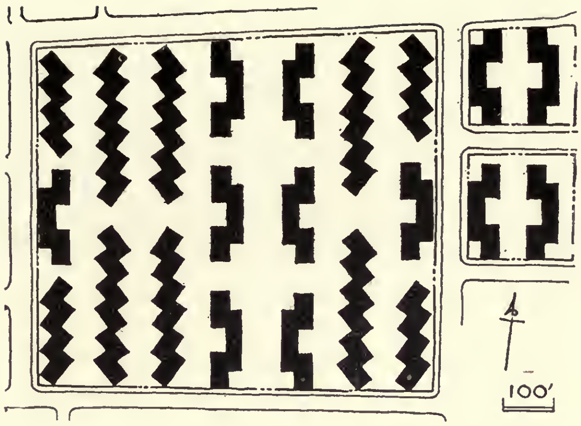
Court plans are often inconvenient and inefficient

Scattered Plans. Scattered plans result from extreme variety of topography or, occasionally, from a reaction against monotonous regularity. Unless justified by topography, a scattered plan is usually disappointing, for nothing is gained in efficiency, cost reduction or appearance.

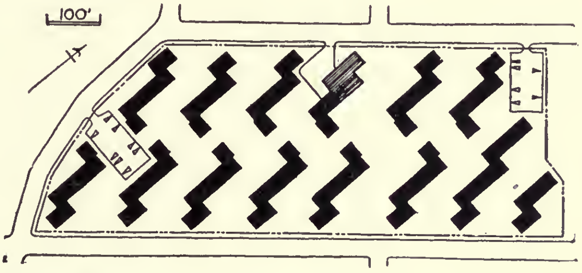
Miscellaneous Plans. In some arrangements the rows are placed to produce, at certain points, the effect of courts. In others, the buildings are in parallel rows, placed rectangularly or in echelon. Apartment house plans show all kinds of modified courts and zig-zag rows. In a few plans the buildings are placed in clusters, each with its own texture.



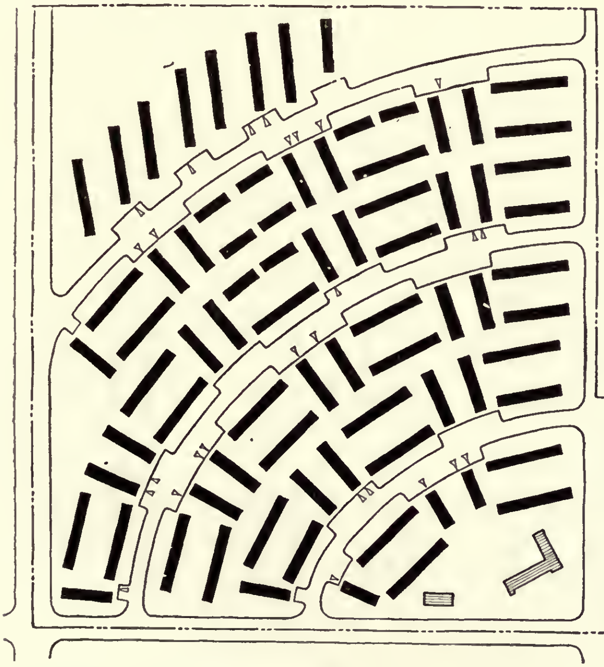
Combination of long rows and courts

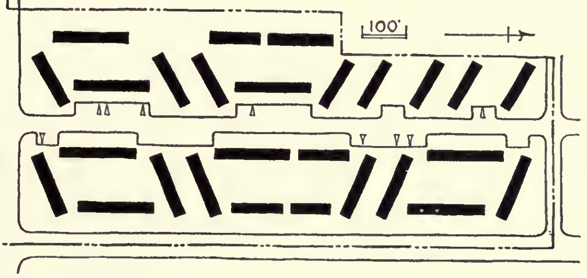


"Zee" apartment units combined in two contrasting forms



"Zee" apartment units combined in zig-zag form





Quadrangles in a variety of forms

Examples of miscellaneous plans

SPACING OF BUILDINGS

The requirements for spacing of buildings as set forth in the "Minimum Physical Standards" are considered necessary to assure a degree of amenity which is desirable wherever women and children spend as much time at home as they usually do in the case of low-income families; and to prevent obsolescence of the project. Consequently, with respect to the spacing between fronts and between ends, the matter merits careful consideration, in order to admit the greatest possible amount of sunlight, to attain the maximum of privacy and freedom from noise, and to afford the widest scope of view. Although the "Minimum Physical Standards" sets minimum distances, only the limits of cost and of reasonableness should limit maxima.

In general, the spacing between fronts, when they face relatively quiet areas rather than streets, is less than between rears, where the land is used more intensively. End-to-end spacing is an important point to study. This area is usually expensive, and amenity within the units is not necessarily increased in direct proportion to the width of this separation. Elimination of unnecessary end space is often the best way to gain width between fronts or rears where privacy and use of outdoor areas are of greater importance. On the other hand, fire safety and free passage of light and air are promoted by greater distances between the ends of buildings.

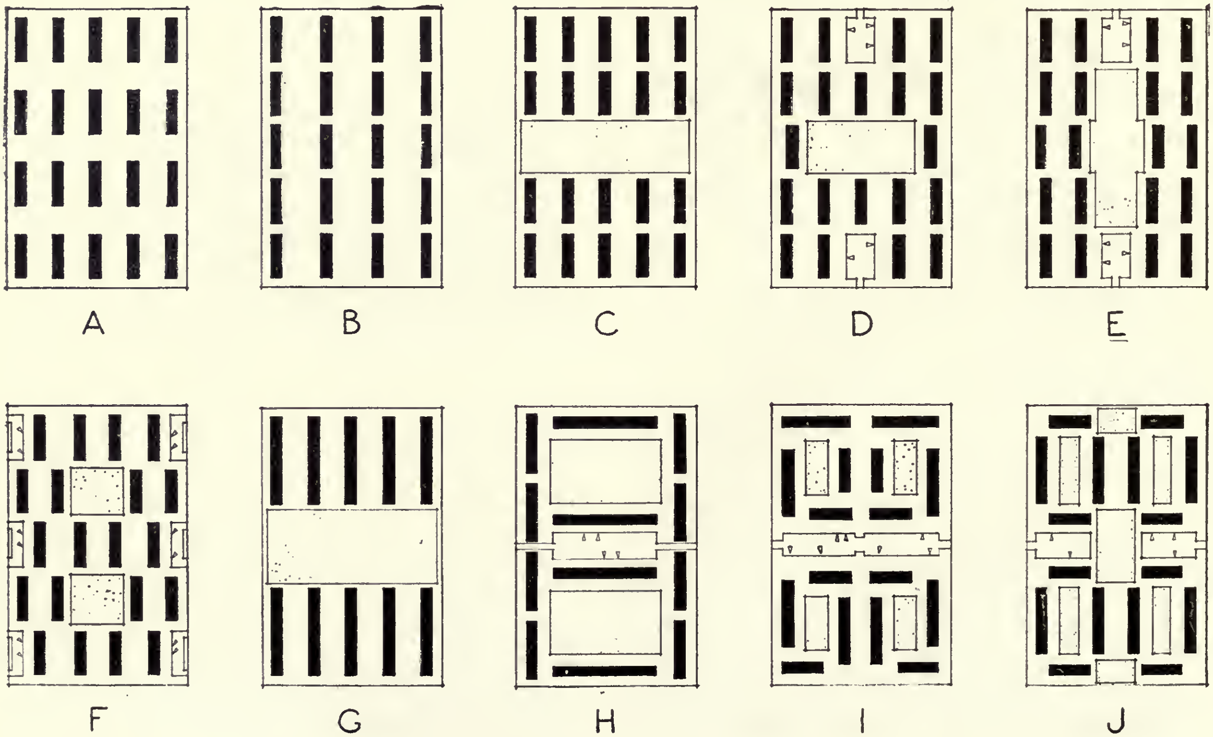
End-to-side separations are usually greater than end-to-end spaces.

RELATION OF BUILDINGS TO TOPOGRAPHY

Few sites are entirely level; many are broken and steep, sometimes so much so as to be considered unbuildable. It is not good practice to fight against the land. Yet many project plans show evidence of this tendency. Level-land plans have been forced upon rugged sites and, occasionally, planning that is characteristic of steep or rolling sites has been adapted artificially to level land. While in rare cases there may be justification for changing the fundamental character of the land—some of the Pittsburgh projects are good examples—the best planned projects, in this respect, have been those where peculiarities of the land were made their chief virtues. In such cases, the sites, as well as the buildings, were planned to enhance, rather than to conceal, their three-dimensional qualities.

The basic idea is, of course, to follow the contours, but this is a general principle only, and not a rule to be accepted blindly. Twin houses can be dotted along a slope without much change in natural grade, but long row houses and large apartments can follow only the general sweep of the surface. Where the slopes have been steep the following schemes have been used:

1. Buildings are placed on nearly level terraces cut into the hillsides; streets are either parallel to the buildings, and substantially parallel to the contours, or they are as nearly perpendicular to the contours as the maximum practicable gradient permits.
2. Buildings are built in a series of steps following streets which oppose the contours. This is a desirable expedient and one that is frequently seen in hill towns. Many sites warrant particular con-



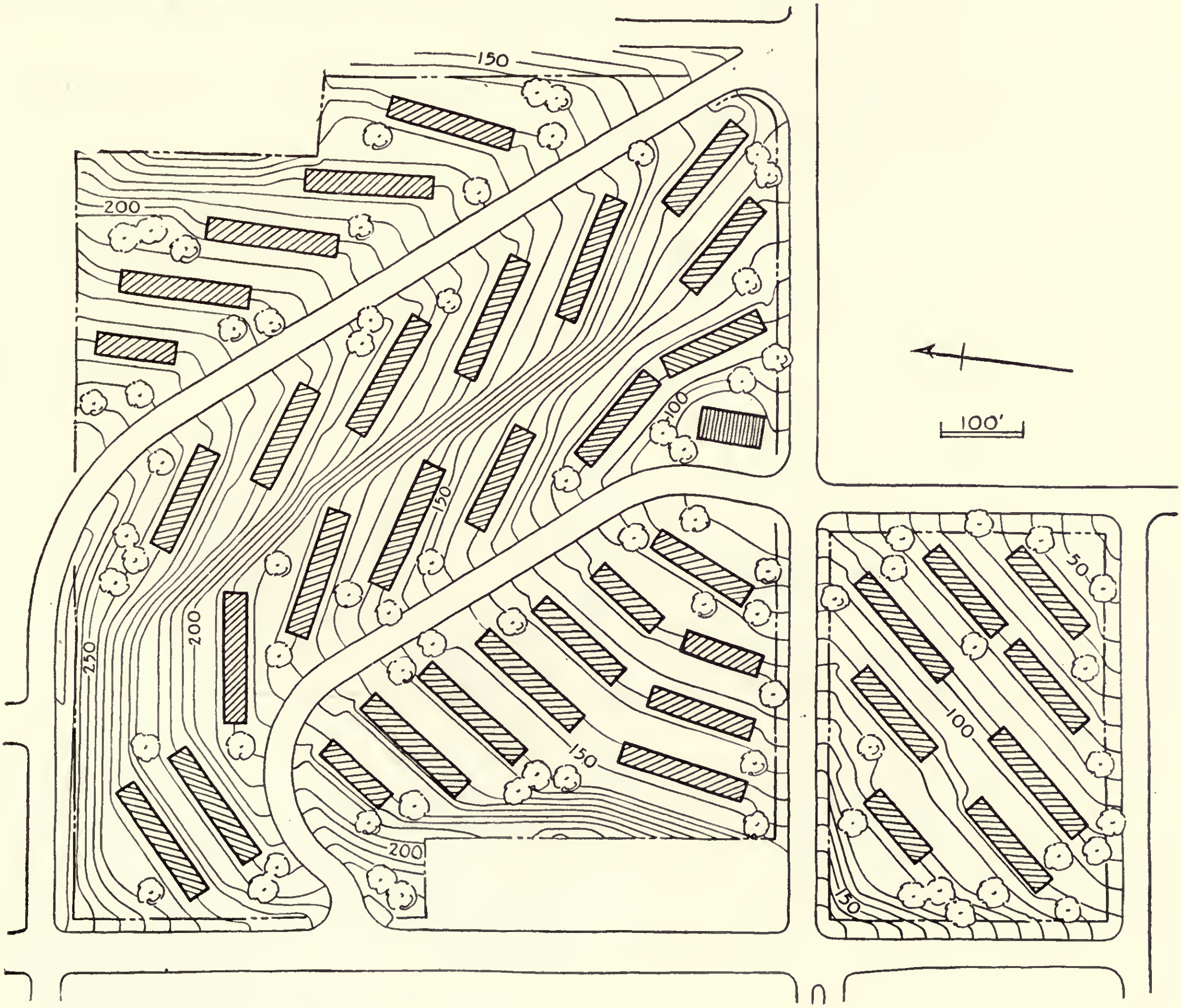
Examples of pooling of open space; each study provides the identical linear footage of building

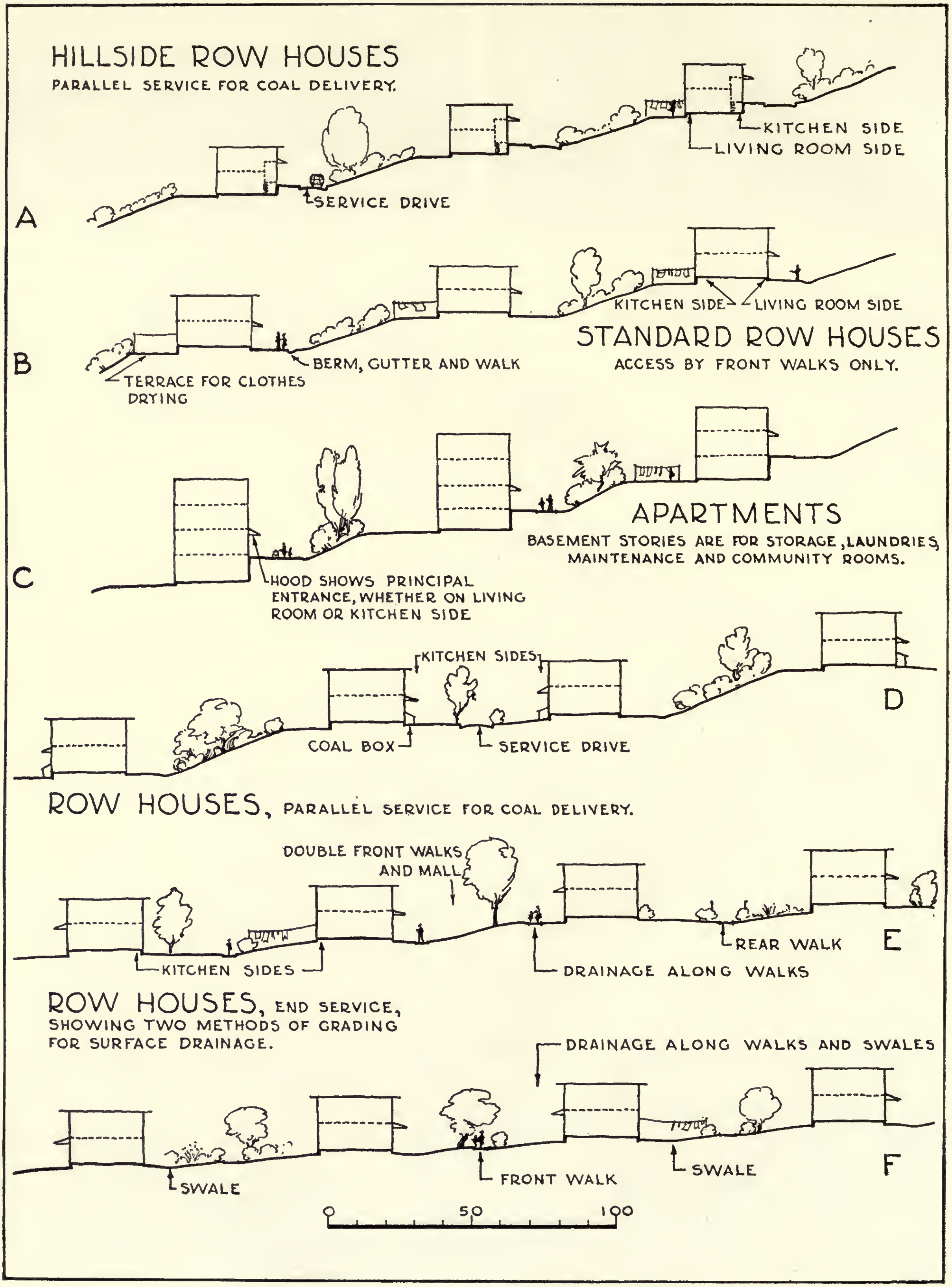
Steep sites: (left) buildings on nearly level terraces; (right) buildings across stepped down with the slope

sideration of this highly interesting approach to building arrangement. Although building costs often tend to be increased, site improvement costs are sometimes very much reduced.

3. "Hillside" units are used. These act as retaining walls to take up the difference in elevation between front and rear yards, usually about half as much as the story height. A precaution concerning such units: hillside units that really simplify site planning make special demands upon the ingenuity of the designer, particularly as to economy.

Hillside units—"garden apartments" in this project—serve as retaining walls




HILLSIDE ROW HOUSES
PARALLEL SERVICE FOR COAL DELIVERY.
A
SERVICE DRIVE
KITCHEN SIDE
LIVING ROOM SIDE
B
TERRACE FOR CLOTHES DRYING
BERM, GUTTER AND WALK
KITCHEN SIDE
LIVING ROOM SIDE
STANDARD ROW HOUSES
ACCESS BY FRONT WALKS ONLY.
C
APARTMENTS
BASEMENT STORIES ARE FOR STORAGE, LAUNDRIES, MAINTENANCE AND COMMUNITY ROOMS.
HOOD SHOWS PRINCIPAL ENTRANCE, WHETHER ON LIVING ROOM OR KITCHEN SIDE
KITCHEN SIDES
D
COAL BOX
SERVICE DRIVE
ROW HOUSES, PARALLEL SERVICE FOR COAL DELIVERY.
DOUBLE FRONT WALKS AND MALL
E
KITCHEN SIDES
DRAINAGE ALONG WALKS
REAR WALK
ROW HOUSES, END SERVICE, SHOWING TWO METHODS OF GRADING FOR SURFACE DRAINAGE.
DRAINAGE ALONG WALKS AND SWALES
F
SWALE
FRONT WALK
SWALE
0
50
100

Relations of buildings to slopes: the general scheme must be determined in the early stages of planning

ORIENTATION

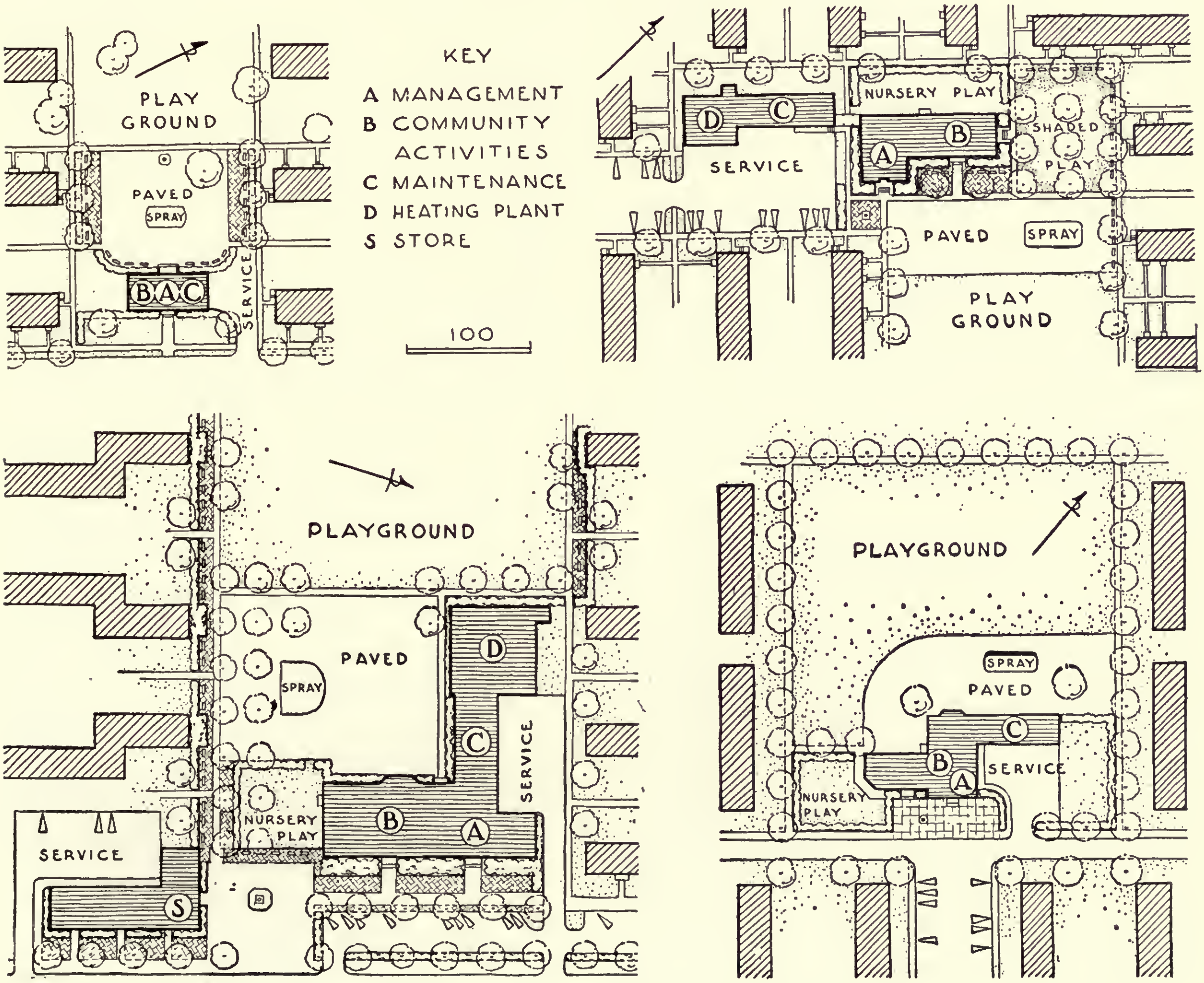
Most planners of housing believe that orientation with respect to the sun and wind is important, but they have diverse views as to its relative importance and what to do about it. They all agree, however, that in moderate or cold climates it is good to have sun in a house for psychological effect at least, and that the benefit of admitting the maximum of summer breezes in most climates is beyond question.

Orientation for sunlight is a difficult technical problem and one that cannot be covered here. It is complicated by the wide range of geographical and climatic conditions in this country, and by the fact that every building in a project cannot be oriented alike without risk of jeopardizing other features of equal importance. Experience shows, however, that designers will find it fully worth while to study the problem with special reference to local conditions.

Orientation for summer breezes is no less difficult. Much can be done to increase summer comfort by arranging the dwellings with lines of air flow through them having the same general direction as the prevailing summer breezes. It is essential, of course, to have valid data on seasonal wind directions; traditional local impressions are often surprisingly incorrect.

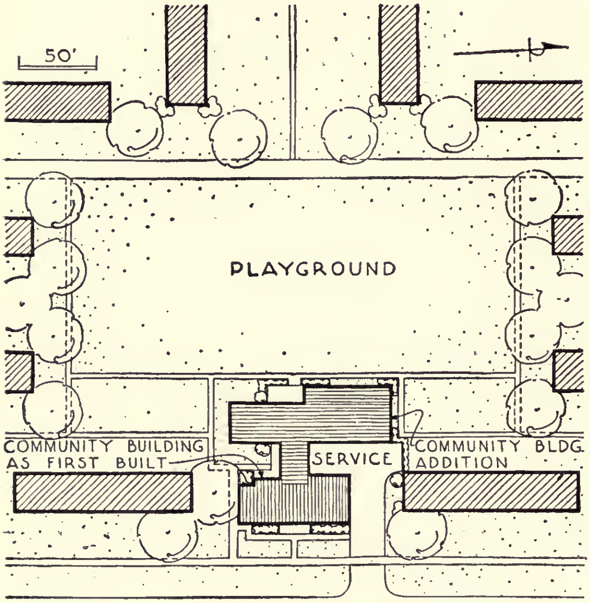
Location and Arrangement of Community Buildings

Space for administration, that is management and maintenance services, and for community activities, is usually combined in one community building or in a closely related group of buildings,



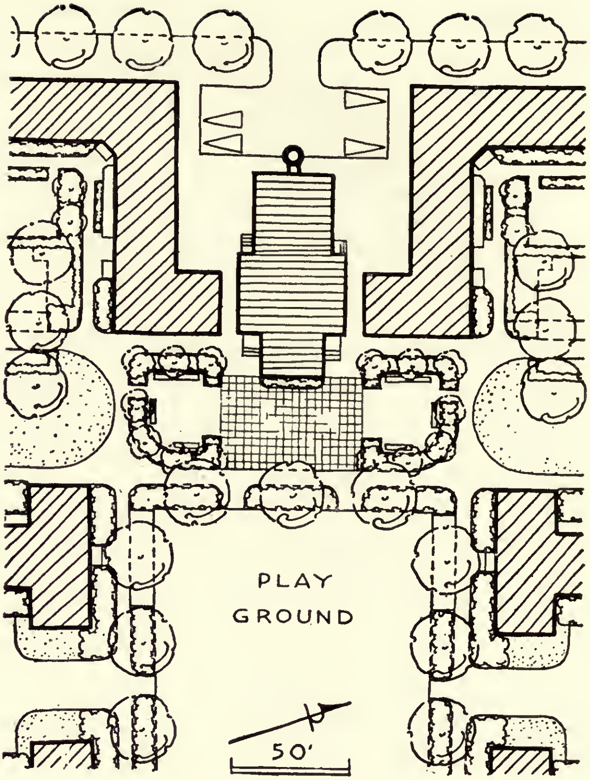
Studies for the arrangement of community buildings frequently known as the project center. This center, preferably planned as a unit with the principal recreation area, should be located where it can be reached easily from all parts of the project. Location on an important project street is essential, and visibility from an important entrance to the project is desirable.

The location of the principal recreation area in many cases determines the placing of the community center in the project. Land too low for building, or filled land, can be used for play. Occasionally, if the site is steep, with no opportunity to form a level area by filling, it is necessary to use the best land for play. (A slope of over 4 percent greatly reduces the value of a playground.)



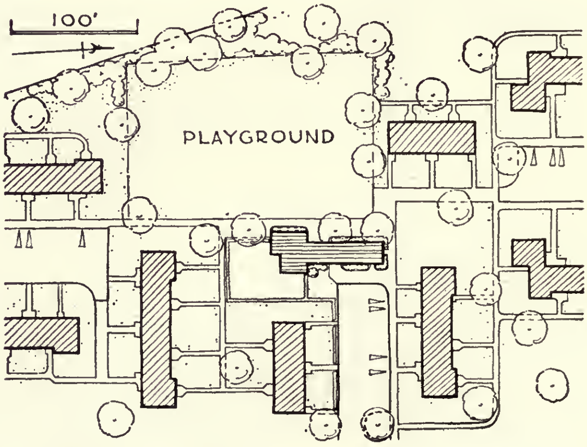
This addition reduced much needed play space

The "Minimum Physical Standards" requires that space be provided for the possible future expansion of the community buildings. Changes in local conditions which cannot always be foreseen when a project is built frequently require an addition to the project, with a corresponding extension of the community building. In some instances lack of adequate space between the community building and nearby buildings, walks, drives, or tenant yards, has necessitated an extension of the community building into the play area, reducing it in size when it, also, should have been enlarged.



Location of this community space prevents expansion

Both the buildings and the play area of the project center should be arranged with a view to reducing possible annoyance to tenants in adjacent residential buildings from noise, lights or dust consequent on the use of these facilities.



End relation of dwelling buildings to playground reduces annoyance to tenants

Circulation

PROJECT STREET SYSTEM

The principal objectives in planning the interior street system are economy and simplicity in the relation between the principal project streets and the minor streets which service the buildings. Related factors are: surface drainage, orientation (of buildings), topography, access to community center, and fire protection. In studying the system, the basic principle of the superblock should be kept in mind, that is, to reduce and slow all vehicular traffic within the block and to keep it free from all through traffic.

It is important, also, to secure all of the available pertinent information possessed by the municipality: data on traffic volume, present and anticipated; the physical plan and condition of adjacent street system in detail; which streets can be vacated or closed; which utilities can be shifted; what changes are contemplated, including changes in width and setback; and what possibilities there are for the dedication of all or part of the project streets. Any streets that can be dedicated to the city save the project the cost of lighting, maintenance and repair. It should be borne in mind from the outset, however, that cities cannot be expected to accept streets that do not conform to their requirements. All requirements, therefore, should be ascertained in detail and embodied in the design when it appears probable that dedications will be effected.

Streets represent a heavy investment and their maintenance is a considerable part of project operating cost. The number of streets and their length and width should be scrutinized from the start of planning to insure that nothing is included that is not essential to the smooth and agreeable functioning of the project as a whole. This is a principle of good planning for which the planner may have to fight, but he will be supported by the general recognition that most cities are over-capitalized in public improvements, particularly for streets that are more numerous and of greater width than is justified.

> Build service roads in rear of all buildings to facilitate deliveries, trash and garbage collections. — New York

> Our experience and observation indicates that it is not necessary to provide service driveways for access to each individual dwelling unit. This, of course, does not apply when coal is used for fuel and delivery to the tenant's box is necessary. — Regional Report

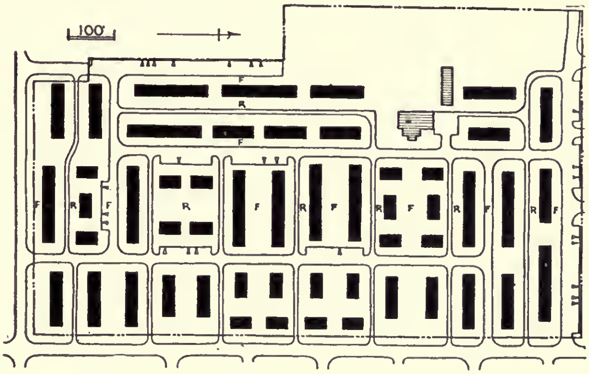
Street cross sections should be determined at an early stage, and other engineering features, such as those related to the paving and surface drainage system, should likewise be fixed as soon as possible. All of these have a bearing upon the site plan. See "Grading and Surface Drainage" in "Site Engineering". From experience, the following recommendations as to width of project streets are offered:

TABLE I

RECOMMENDED STREET WIDTHS

Type of Use	*Width in feet*
Two lanes (occasional parking only).....	[1]18
Two lanes (with tenant car parking):	
parallel parking, one side.........	26
parallel parking, both sides........	32
diagonal parking, one side........	36
diagonal parking, both sides.......	52
perpendicular parking, one side....	40
perpendicular parking, both sides...	60

[1] 20 feet in regions of heavy snowfall

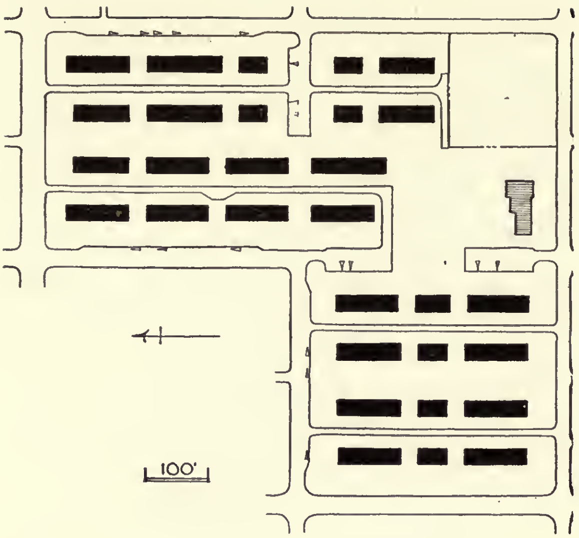


The principal streets, between fronts and ends, are supplemented by service drives between rears

SERVICE DRIVES

The loop or "U" service drive has proved preferable to the dead-end drive because it combines convenience of circulation with freedom from through traffic. Suitable maximum lengths depend upon population served, pavement width, location of fire hydrants, and parking system. Dead-end drives may be as long as 350 feet; 700 feet is the recommended limit in depth for loop or "U" drives.

Dead-end or cul-de-sac drives, if longer than 100 feet, should terminate with a "Y," "T" or circle for turning. Two lane drives should be 16 feet wide.

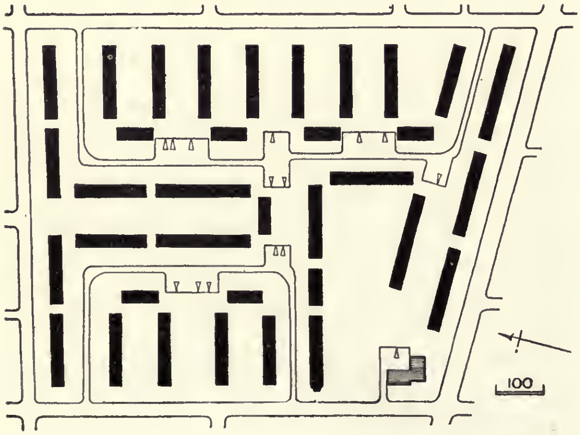


Straightforward use of 10-foot service drives

So far as possible service drives should be only one lane wide (10 feet); these are unfavorable for parking and discourage unnecessary traffic and, therefore, may be used with greater safety for pedestrian traffic than two-lane drives. In practice the following limitations define the proper use of one-lane service drives:

1. One-lane drives should be short; 800 feet is the normal limit.
2. Passing or turning places should be about 300 feet apart.
3. Visibility from end to end should be unobstructed; if not, turning or passing places should be provided at changes in direction.
4. One-lane drives should not be used for main access to dwelling units.
5. One-lane drives should not be used for two-way access to parking courts unless the drive is short and straight and serves no more than six cars.
6. There should be a strip of grass or paved walk (at least two feet wide) to permit pedestrians to step off the drive at any point.

Unreasonable use of 10-foot service drives



Tenant yards chewed up by cars because service drive is too long and narrow. — Connecticut

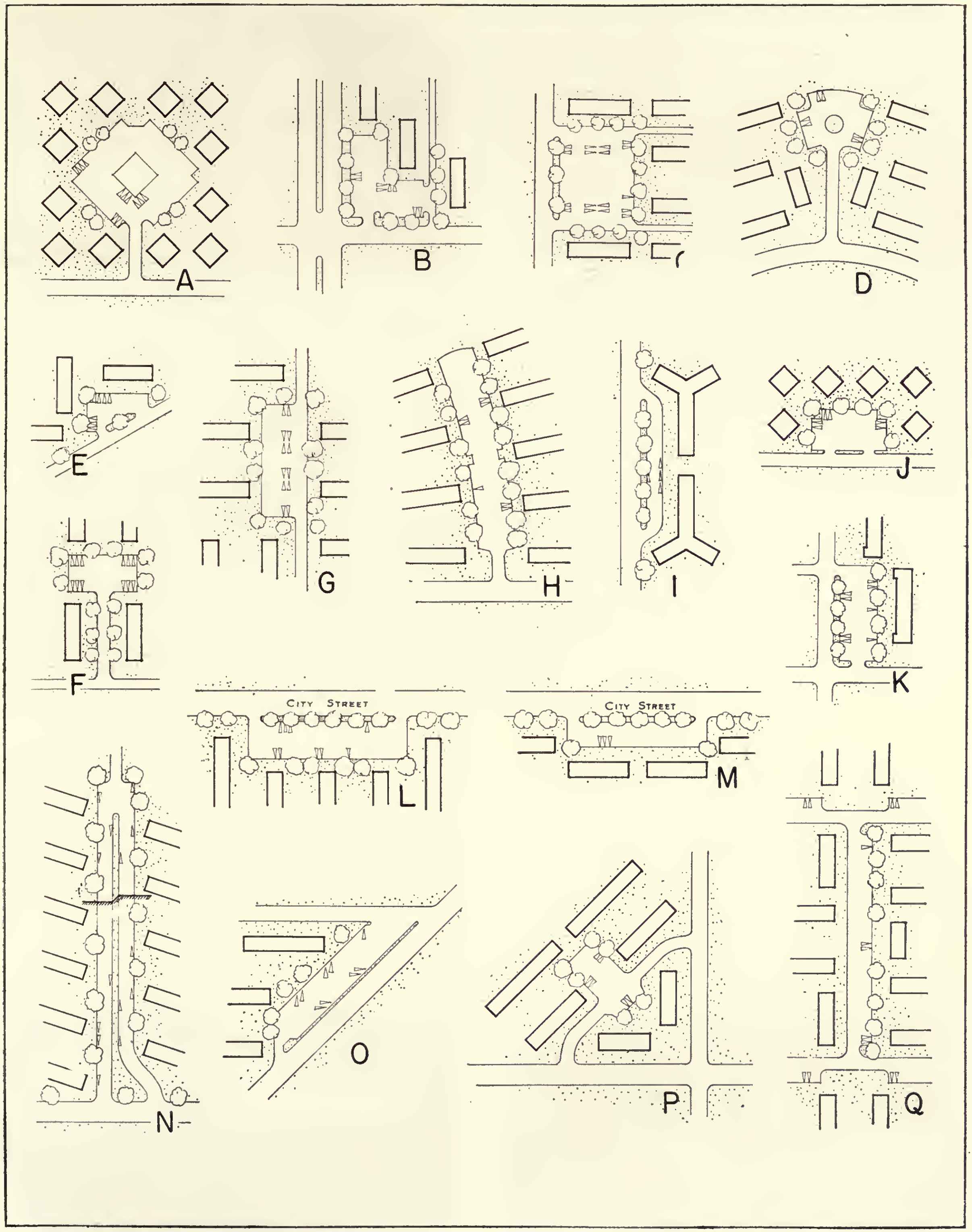
PARKING SPACE

Tenants of public housing projects own and use automobiles as other economic groups do. Although the percentage of ownership varies widely it seldom has been less than 25 percent and often has been above 75 percent. Such a wide variation can be accounted for, in part at least, by diverse situations with respect to location of employment, availability and kind of public transportation, and by the accessibility of shopping centers, churches, schools, and places of amusement. The percentage of car owners has gradually continued to increase, and there is nothing to indicate that this trend will not continue.

Failure to anticipate the need for parking and to meet it as part of the project design would not be good planning. If the parking problem is ignored, the tenants will probably park their cars on the perimeter streets and beyond, so far as needed, possibly in violation of current or unforeseen future local regulations and certainly to the detriment of other neighborhood residents. If the need were only partially met, a similar, if less acute, situation, would result. This question, therefore, should be given the most thoughtful attention at the very start of planning.

Off-street parking courts, as a general rule, are preferable to on-street parking space. For convenience and car protection, tenants favor frequent and moderately sized courts to fewer, larger ones. Where coal is used as a fuel for individual heating plants, the use of parking spaces adjacent to the units is sometimes justified and is always much appreciated by the tenants. In most cases the plan and position of parking courts will be influenced by the need for using the pavement for other functions, but the following points should be kept in mind: courts should be placed near traffic streets, near dwelling units, and in end relation to buildings.

Street parking space is the cheapest that can be



Examples of parking areas designed to meet a variety of project conditions provided. It has however, certain definite disadvantages: inconvenience and danger from street traffic; risk of theft; poor appearance; inconvenience in washing and repair of cars; and possible legal restrictions, if streets are to be dedicated.

Basic dimensions for the design of parking spaces are: a space 6 feet by 20 feet for cars parked parallel, and 8 feet by 20 feet for cars parked perpendicular; in the latter case a 30 inch overhang beyond curb should be provided; 10 feet for each traffic lane.

PLANNING THE WALKS

The total walk area per dwelling unit varies considerably in different projects. In some, walks surround every building; in others, service drives provide the only pedestrian routes. In projects of high density there are usually numerous walks. Although the need for economy must be kept in mind, a good walk system that promotes convenience is a sound investment in all projects.

> Walks should be provided on all through streets to protect children going to and coming from school. — Regional Report
>
> Sidewalks needed both front and rear of dwelling buildings. — Texas
>
> Sidewalks needed at rear. — Georgia

A classification of walks is useful to provide uniform terminology and to serve as a check on the scope of this feature of planning:

1. Sidewalks: parallel to city and project streets.
2. Collector walks: not parallel to streets; designed for general circulation.

This short-cut provides directness of access which is lacking in the walk system

3. Approach walks: leading to buildings or groups of buildings from other walks, streets or drives.
4. Entrance walks: leading directly to dwelling or building entrances.

The walk plan should be functional, built up of primary, secondary and tertiary elements, each adjusted in location, width and material to serve its purpose. Directness of access is essential. Otherwise most people seem inclined to "short-cut", unless they are funneled into the intended paths by planting or barriers. Adults are the most difficult to cope with; they make and then follow beaten tracks, whereas children either scatter in every direction or play on the paved areas.

> Many complaints of paths leading to project facilities, streets, trolley lines, and so on being worn in lawns because paths do not follow the natural path of circulation. In many cases this has necessitated the construction of supplementary walks or fences to protect lawn areas. In all cases, functional rather than formal design should be followed in designing walks and drives. — Regional Report

These rear yards lack approach walks

Walks are popular outdoor play spaces for children

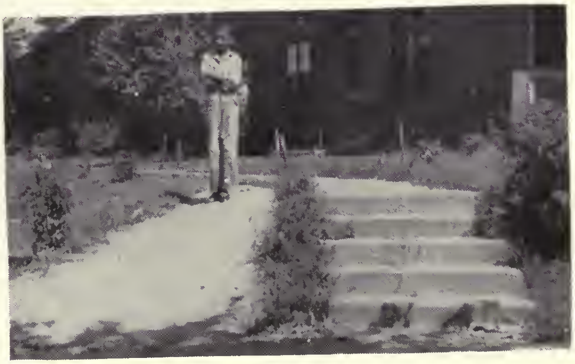
Walks are the most popular outdoor play places for children. This play—particularly roller skating on concrete walks—is noisy, a point to remember in locating walks near dwellings. If a smoothly paved circuit not close to or paralleling the dwellings can be made to serve the project, it will attract children and keep them from places where noise is more objectionable.

There are advantages in using two kinds of materials for certain walks; for example, a center strip of concrete flanked by strips of brick. This tends to confine ordinary traffic to the center, thus protecting the adjacent grass, while providing ample width for passing and for occasional heavy traffic.

In planning walks it should be remembered that they are used in all weather and that they are often poorly lighted. They should, therefore, be free of steps if possible. When steps are necessary, not less than three should be used. Sharp turns should be avoided and islands for planting, play, or other purposes should not be permitted to interrupt the free flow of the walk.

Ramps are preferable to steps; if ramps alone do not seem adequate, they should supplement steps for the convenience of baby carriages and bicycles. — Pennsylvania

Mute evidence that tenants prefer ramps to steps

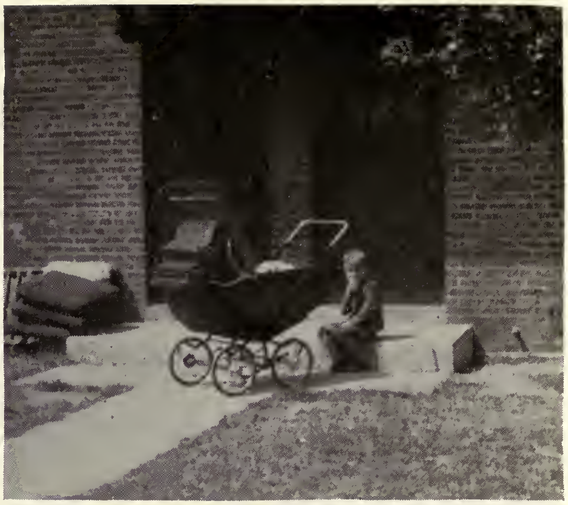


The widths of walks have nearly as much effect upon project cost as their linear dimensions. When the walk pattern has been determined upon an economical basis it would not do to waste what has been saved in lengths by extravagance in fixing the widths. The walks should not be so skimpy in width as to be useless, causing destruction of bordering grass or high maintenance costs. It should be noted, however, that the traditional rules for widths are based upon ideas of generous rather than normal convenience. A fair rule is to make the much-used walks as wide as the budget will permit and the little-used walks as narrow as possible, even though occasional inconvenience may result.

The following minimum walk widths are recommended for most conditions:

1. Apartment projects: for principal circulation, eight feet minimum. Other walks, six feet, but entrance walks should have enlargements for baby carriages.

> Apartment entrances require ample room around them for people to move in and out and for parking baby carriages. These areas should be so laid out as to handle as directly and expeditiously as possible the volume of traffic for the particular stairhall, and at the same time prevent congregating near the adjacent lower floor apartment windows. — New York



Skimpy pavement results in destruction of bordering grass and in high maintenance costs

2. Twin and row house projects: Sidewalks proportionate to anticipated traffic, but a minimum of five feet (plus six-inch curb) if cars are parked perpendicular to walk. Collector walks four to five feet, dependent upon density. Front approach walks, four feet; rear approach, three feet. Front entrance walks, serving one or two units, two feet; rear entrance walks serving two units, two feet; one unit, sixteen inches.

Ample paving at dwelling entrances is useful for parking baby carriages and sunning the baby

Service Arrangements and Details

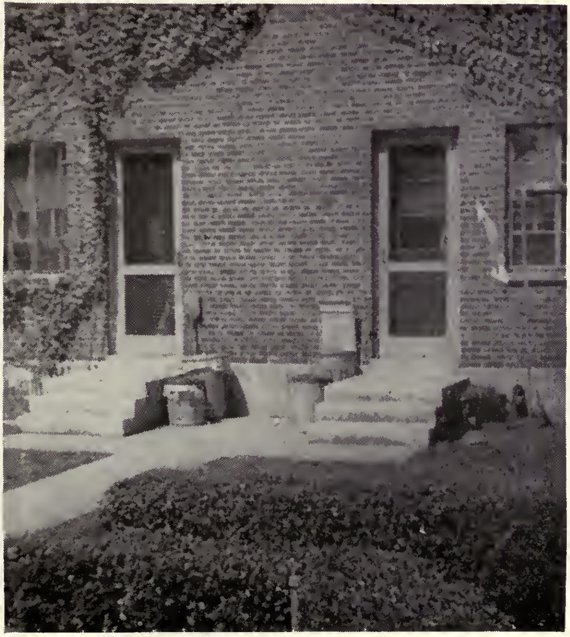
WASTE REMOVAL

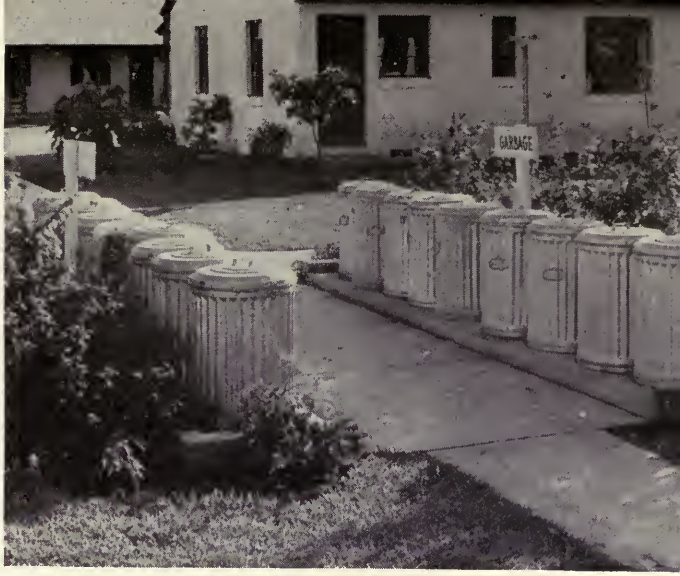
The collection and disposal of garbage and rubbish are fundamental considerations in the planning and operation of projects. Sanitation, convenience, economy and relative inoffensiveness are the objectives. At best, these services are expensive: projects planned for tenant co-operation will permit economy in design and, if such co-operation is obtained, will reduce costs to the project and to the city.

The two chief factors affecting the planning are the amount of material to be disposed of and the manner and frequency of collection. As to the amount, this varies with the season and, to a more limited extent, with the economic status of the tenants. The use of coal stoves reduces the quantity of combustible rubbish very materially. Based on experience data, the following container sizes are suggested: for garbage, 8 gallons (family of four) 10 gallons (larger families); for rubbish, 25 gallons; for ashes, 20 to 25 gallons.

While most municipalities provide waste removal services, there are many local variations, including what is collected, what mixtures, if any, are permitted, the manner and place in which waste shall be made available for collection, the time and frequency of collection—all highly important to project design and operation. These things must be known and understood by the designer at the beginning of his work; otherwise, failure with respect to this important problem can be avoided only by the merest chance. No single factor of project operation contributes more to project success than a well thought out system of waste removal and disposal.

Location of waste receptacles for individual families is planned for convenience



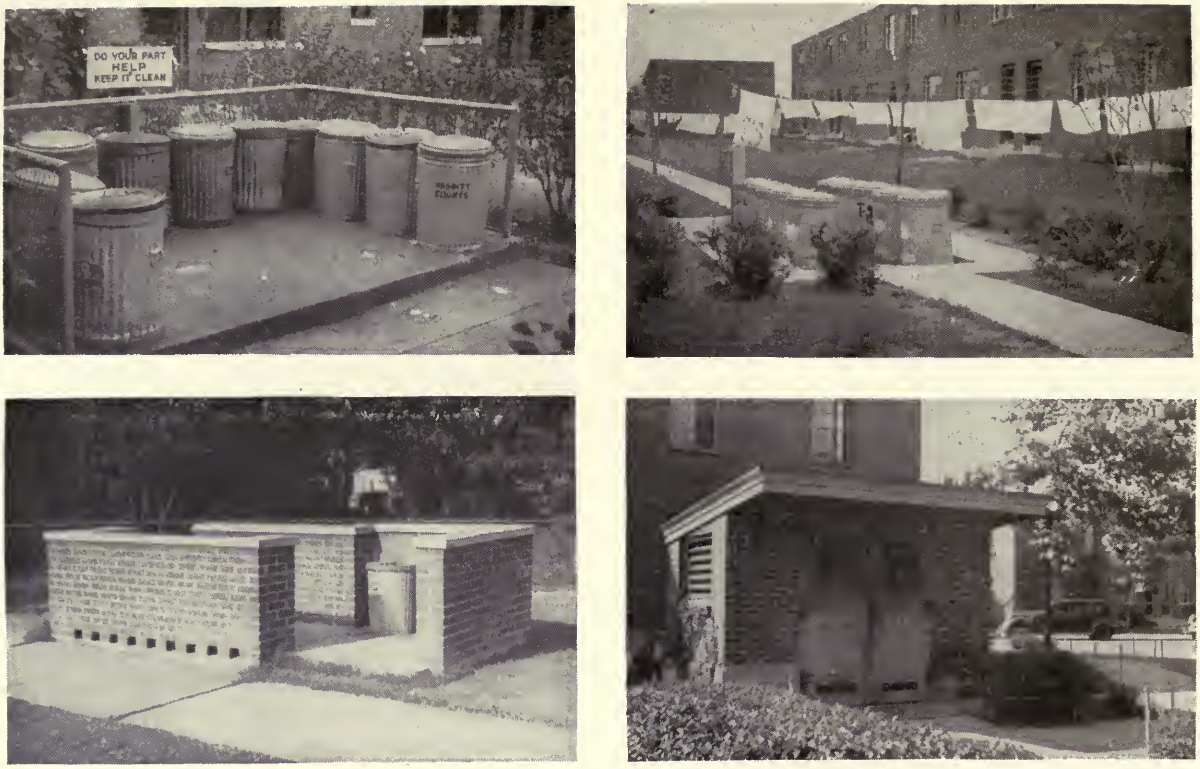


Waste collection stations which straddle walks are not altogether satisfactory

Location of waste receptacles for individual families should be planned for convenience and inconspicuousness. Each family usually supplies its own cans for rubbish and ashes. Frequently receptacles are placed near an outside coal box or oil drum. Their location should be predetermined and definite provision for their storage should be made.

Waste collection stations serving groups of families are used in many projects where house to house collection is not provided. This arrangement has generally proved unsatisfactory, but if after serious consideration it is decided upon, the stations should be designed and located with extreme care. They should be placed at points convenient both for collectors and for the families served. Locations at one side of a walk have proved to be more satisfactory than those which straddle walks.

The stations usually consist of a simple pavement or platform with some sort of enclosure to keep the cans in place. Low curbs are adequate for this pur-



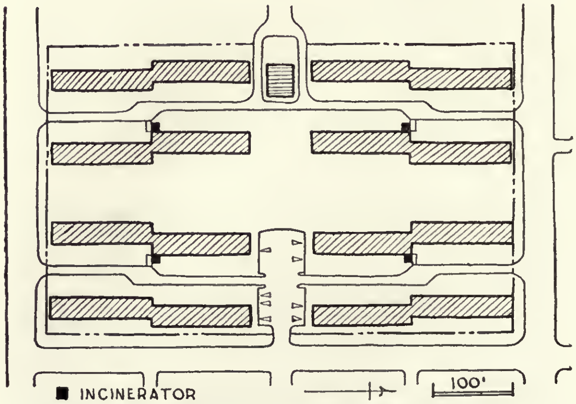
A variety of waste collection stations

pose but low walls or fences are sometimes used. In a few instances roofs are provided—a desirable protection in localities where there is much rain or snow. Water and drainage connections usually are required for each station. Platforms parallel to walks should be designed for not more than six cans; the effect of longer rows is unpleasant. Larger numbers should be arranged in a rectangular court. Screening, by means of planting or other device, is often provided for stations, particularly for those visible from important walks or streets. All such screening should be somewhat higher than the cans.

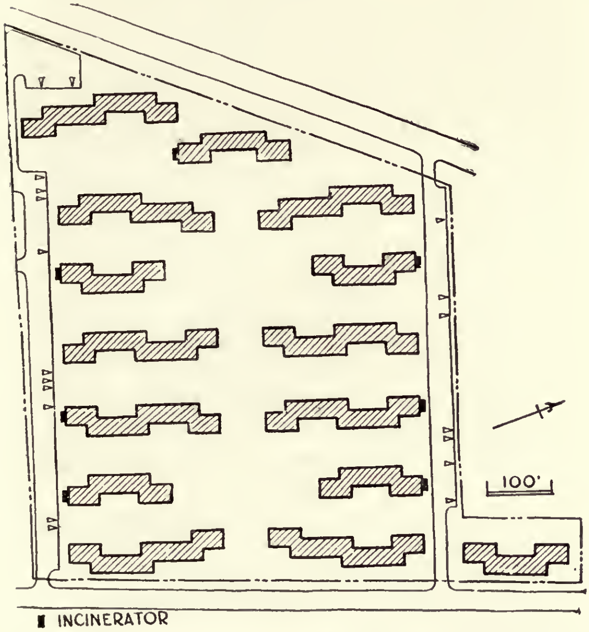
Garbage cans at project collection stations are usually of 27 gallons capacity, the limit for one man to handle; this can is generally 18 inches in diameter by 24½ inches high. Rubbish cans are usually of the same height but two inches larger in diameter.

> Group collection stations for trash are o.k. but should serve less than 25 families each. — Regional Report
>
> Due to the fact that trash is collected only once a week and because of occasional delays in the city trash collections, it would be most advisable for all projects to have small incinerators constructed in the maintenance building. This would be a big help in keeping the projects clean. — Pennsylvania

Incinerators have been used in many projects. Tall apartment buildings usually have incinerators serving each stair hall with an opening on each floor. In some projects, generally walk-up apartments but sometimes flats and row houses, incinerators are accessible only from the outside and at grade. A few projects have their own central incineration plant, but this system of waste disposal is



A row house project serviced with incinerators likely to be expensive. The details of the incineration system are not primarily the concern of the site planner. He must, however, correlate the locations of incinerators with the street and walk system and be familiar with their operation so that he can provide suitable access to them.



An apartment project serviced with outside incinerators

FUEL DELIVERY AND STORAGE

The kind of heating system planned, that is, central, group or individual, and the type of fuel used, coal, oil or gas, affect the arrangement and cost of site development. For coal-burning equipment, street pavement should be within the distance locally practicable for the economical delivery of coal; wherever possible, chuting from truck to bin is highly desirable. The use of hand-operated carts and of bagged coal should be investigated if conditions are not favorable for street access to all dwellings.

Local oil delivery limits from truck to storage tank vary and consequently have to be checked; they are usually between 100 and 200 feet, minus 10 feet for handling the hose. On sloping sites, the difference in elevation between the service drive and the storage tank must also be checked.

Where coal is used, storage for kindling and fire wood is essential. For cutting kindling, a suitable paved or gravel area should be provided. This is usually planned as a part of the space for waste receptacles and coal bins, if an outside bin is provided.

> If bins are not properly located for deliveries it will result in trucks backing over lawn areas to reach the bins with the resultant damage to walks and other facilities. — Virginia

FENCES

Fences of many types have been provided for a variety of reasons, most of which concern the protection of children and of clothes drying or the reduction of supervision or maintenance problems, especially those relating to lawns and planting.

Most managers have found that fencing of some kind is necessary to protect lawns and shrubbery, both in public areas and in individual yards, particularly at walk intersections, near the tops of banks, along ramps and steps, and near apartment building entrances.

> Pedestrians' short-cutting through shrubbery and over lawns is cause of much damage. Hedges, supplemented by chain link fences, reduce cross walking at corners. — New York

Fences for individual tenant yards have been erected in a number of developments, either as part of the original contract or later—in some instances by management, but frequently by the tenants themselves. The method of fencing tenant yards varies widely, from the complete enclosure of each yard to simple divisions between yards. Occasionally, all of the yards in the rear of a building are enclosed as a group, no divisions being provided within the group.

Fences of various kinds erected by tenants

Fences provide protection for flowers and a feeling of privacy

> No dividing fences or hedges, and tenants complain that there is a lack of privacy and of protection for children, flowers, laundry. Management has allowed tenants to erect their own fences in rear but not in front yards. — Pennsylvania
>
> In row houses back yards should be fenced as part of the original contract. We had no fences to begin with and the back yards problem was terrific. — Connecticut
>
> Fenced rear yards will go a long way towards solving the problem of little children's play. Any kid likes to have other kids come in and play with him in his own back yard. There he can dig holes without interference. — Georgia
>
> Back yards to be fenced in, in post-war housing. — Alabama

Gates are considered desirable when tenant yards are fenced, despite some reports that they are badly damaged by children swinging and climbing on them.

> If gate is not provided an unreasonable facsimile is bound to appear. — California

Fencing of common laundry drying yards is quite generally recommended: gates, however, are not ordinarily practicable.

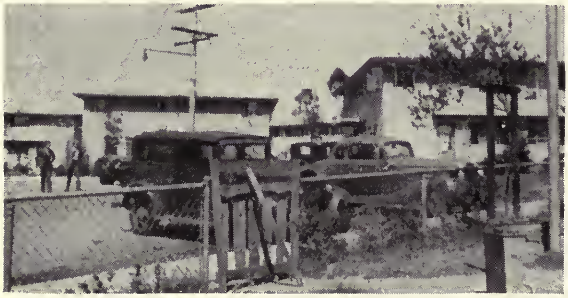
> Drying yards should be enclosed with a fence. — Regional Report
>
> Unfenced drying yards are used as playgrounds. — Connecticut
>
> Drying yards here need high fences to prevent clothes being blown away by high winds. — California

Fences for large play areas and for small children's play areas are usually recommended, in order to facilitate effective supervision of the play program. Fences are always needed between play areas and bordering streets, parking areas, service courts and tenant yards. Gates are essential for child-service play yards but are not normally considered desirable in fences around general play areas.

> Lack of fencing prevents use of play area for supervised play program, since Recreation Department will not furnish supervisor until it is fenced. — Florida
>
> Local play areas for small children should be fenced. — Washington State
>
> As it is now, we worry about the little ones running around loose. — Pennsylvania
>
> High fences should be provided between play areas and streets. There should be no openings on the street side. When a ball goes into the street children dash out after it without looking out for the traffic. — Maryland

Fences are frequently used to enclose or to screen rubbish collection stations. Gates are not usually required.

Fences should be, but are not always, provided between a project and a bordering railroad track, or any other particularly hazardous feature.



Tenants sometimes provide makeshift gates

EXTERIOR ILLUMINATION

Lighting of walks, streets and grounds is ordinarily consistent with local municipal practices. The lighting should be of moderate intensity but well distributed to eliminate dark areas (particularly those planned for general use) and to give good illumination to steps in walks, street ends, and other danger points. When streets are to be dedicated, the street lights should be located, so far as possible, so as best to serve the project itself. Supplementary lights maintained by the project are placed as needed to illuminate walks to dwelling unit entrances from public streets, sidewalks and parking courts. Often such lights are attached to the building walls. See "Electrical System" in "Mechanical and Electrical Design."

FLAGPOLES

These are usually provided where they will be convenient for patriotic ceremonies and other outdoor gatherings; normally flagpoles are 30 to 50 feet high.

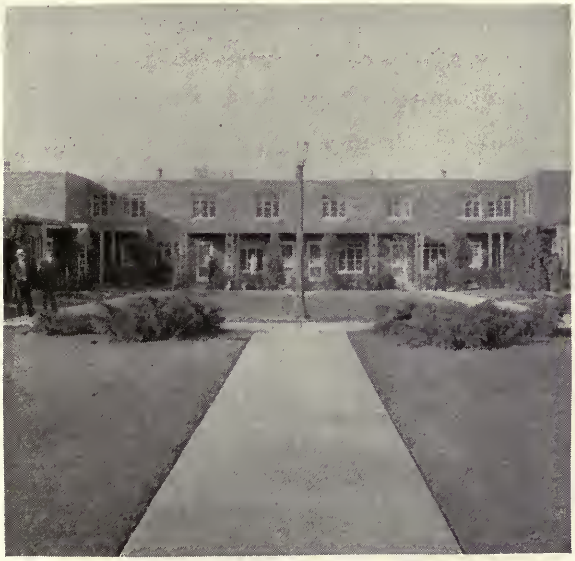
PUBLIC TELEPHONE BOOTH

One public telephone is usually provided at the community building. Others may be required on large projects, unless public telephones are available nearby at all hours of the day and night.

In some apartment developments public telephones have been placed in the stair wells of certain buildings near the entrance doors, on which a public telephone sign is displayed and well lighted for easy identification at night. Occasionally public telephone booths have been attached to or incorporated in yard stations. In many projects single booths are located at or near walk intersections in various parts of the project; occasionally several are grouped at a point convenient to a large number of dwellings.

STREET SIGNS

Signs for street names and for traffic control are ordinarily provided. The types and location should be worked out in agreement with local bodies having jurisdiction. House numbers should be assigned at the same time.



Light standards on the axis of formal courts interfere with the view of the buildings

Land Use

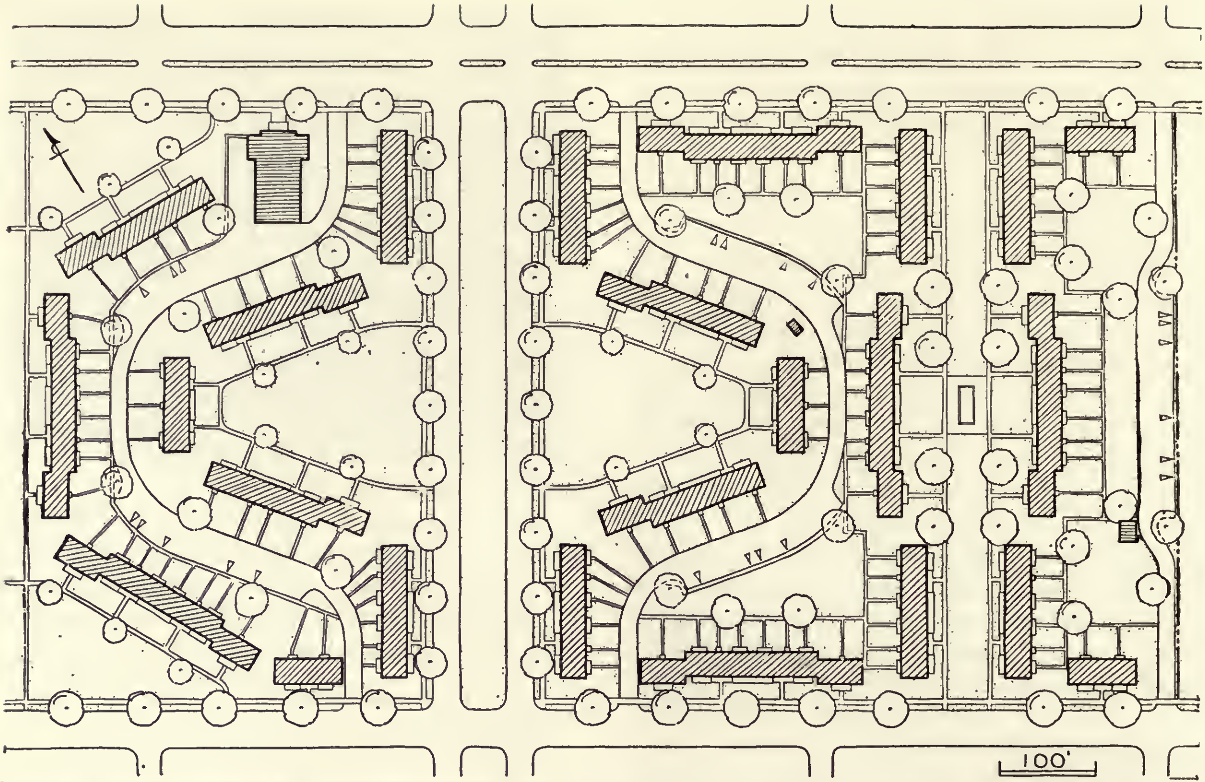
The term "land use" denotes, in terms of design, the allocation of all the outdoor areas of a project for various selected functions. No phase of site planning is more important than that of determining land use. Unless it is accomplished at an early stage, it is likely to be done thoughtlessly and badly.

The main interest of tenants in a project, other than the dwellings, lies in what the project offers outdoors for practical use and for recreational and esthetic enjoyment. In every public housing project the satisfaction or dissatisfaction of both tenants and management has resulted to a considerable extent from the land-use policy.

The formulation of a definite and authoritative policy on this subject should be discussed and agreed upon before the site plan has advanced beyond its initial stages. One or another of the following considerations will usually influence the general policy:

1. Desire for pleasing general appearance, particularly for lush planting arranged to "set off" the buildings; little consideration given to cost of maintenance or to planning for either tenant or group use.
2. Preoccupation with efficiency and uniform neatness; all ground areas pooled in common, with no private areas where trash may accumulate; economy of project maintenance stressed.
3. Stressing of outdoor recreational features; strong emphasis upon community use of land for recreation, active and passive; maintenance by project management or tenant groups or outside agency.
4. Maximum assignment of land to tenants, as private yards, with substantial freedom as to their use; maximum degree of tenant maintenance.

In formulating a land-use policy none of the above attitudes should be over-emphasized. Furthermore, other considerations are of equal or greater importance: the density of the project, the type of dwelling unit, and the needs, customs and land-use background of the tenants. It is difficult, for example, in the case of buildings composed of ground floor flats below two-story row houses to assign space for tenant care and use satisfactorily. In a crowded, slum-clearance project, in a city where several generations have lived in many-storied apartments, the



Esthetics, rather than a reasonable system of land use, influenced the design of this project; the community building location is cramped and much land that might have been assembled into a principal play area is dissipated throughout the project

points of view expressed in the second and third items above are the most pertinent. A wholehearted effort should be made, in this case, to fit the land for the greatest possible use to the tenants, both as to work space and play area.

In a project of low or moderate density, in a

In projects of moderate density the assignment of land to tenant families is the foundation of a successful land use policy neighborhood where at least some part of the people have a tradition of private yards, the assignment of land to tenant families for their exclusive use is the surest foundation for success of the land-use policy. The arguments in favor of the provision of yards need not be pointed out; the manner of including them in the plan, their size and relation to the dwellings themselves, and the method of giving them boundaries and separation barriers, are all matters of local custom and preference. Strongly marked divisions are generally preferred and, when fences or physical separations of any form have not been provided by the project, the tenants nearly always install some kind of enclosure, purchased or improvised.

COMMUNITY AND ALLOTMENT GARDENS

Many families living in public housing projects want land on which to grow their own vegetables. Community gardens (small areas of common project land worked by a group of tenants) and allotment gardens (a sizable piece of land on or near the project site divided among the tenants) afford an outlet for this wholesome desire. Where such spaces were planned as part of a project or later provided in response to tenant requests, they have been popular; tenant participation has ranged from 25 to 75 percent.

The soil in the area provided for vegetable gardens should be suitable for plant growth (or soil which can be made suitable); otherwise tenants

Allotment gardens are popular on many projects

Many tenants like to grow their own vegetables

may become discouraged with their efforts. Tool storage and water should be conveniently available for tenant use. Experience indicates that tenants will walk some distance, if necessary, to their gardens in order to raise vegetables. Where land is available and gardens are planned, tenant participation will be promoted if the dwelling units provide storage space for both canned and bulk vegetables.

Laundry Drying Yards

Nearly all families in public housing projects want and need some outdoor space for drying clothes, airing bedding and the like. This is true even where indoor drying space is provided and must be used most of the year.

> Some of these women are old fashioned. They think there's nothing like the sun for drying their clothes. But we've provided them with the last word in modern, mechanized drying equipment, and we're going to see to it that they use it. — Kentucky

On some projects, where no outdoor drying facilities are provided, women have resorted to makeshift arrangements very irritating and far less efficient than the provision of adequate facilities.

> They even hang things in the window for sunning and airing. — Massachusetts

The individual yard, when it is of adequate size and not too steep, is usually the place for laundry drying; otherwise common yards are desirable.

PRIVATE YARDS

The length of line required is 50 to 60 feet for one-bedroom units, and 75 to 100 feet for larger units. Shorter lengths have proved inadequate, because there is almost always one day a week devoted to a large job of laundering, even if clothes washing is done more frequently, and the weather is not always favorable for drying two lots of washing in one day. Furthermore, when lines converge, as is sometimes necessary, their full length cannot be used efficiently.

Various means, none fully satisfactory, have been used to supplement limited lengths of lines: neighbors use their lines co-operatively, alternating wash days; tenants string supplementary lines to trees, electric poles or whatever is handy; clothing is hung on fences and shrubbery; or the manager is prevailed upon to place additional posts and hooks in spaces which may not be well planned for this purpose.

> More emphasis should be placed on the sizes of rear yards, especially for clothes drying areas. In most of our projects it has meant that the housewives have to work out an arrangement whereby an exchange of clothes lines can be made in order to accommodate their family wash, especially where there are large pieces such as sheets, etc. — Virginia

Posts and hooks are the most practical support for the lines; some suggestions as to their location and detail may be helpful:

1. Lines may run between posts or between posts and hooks on a building wall. Lines parallel to buildings are orderly and are adapted to some yard arrangements.
2. When posts are used as boundary markers they should have wide arms and double sets of hooks for independent use by both families served. The same space should not be used by two families, nor should a line cross a path used by two families.

Clotheslines should not cross a walk used by two or more families

Families in row houses prefer to hang their laundry in their own yards

> One thing that's important: Every family should have its own clotheslines. — California

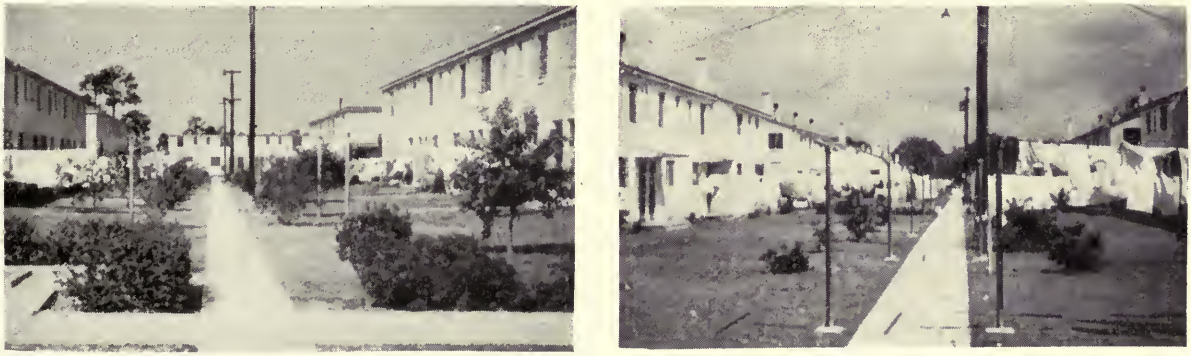
3. Posts and lines should be placed so that one family's laundry will not block another's view.
4. Set-back of posts from drives, especially without curbs, should be at least 2 feet, if lines are perpendicular to them; also from public walks if depth of yard is sufficient. Set-back from drives, public walks, buildings, fences, and hedges should be at least 4 feet if lines are parallel to them.

> Clothes posts set too near service drives are easily damaged. — Florida

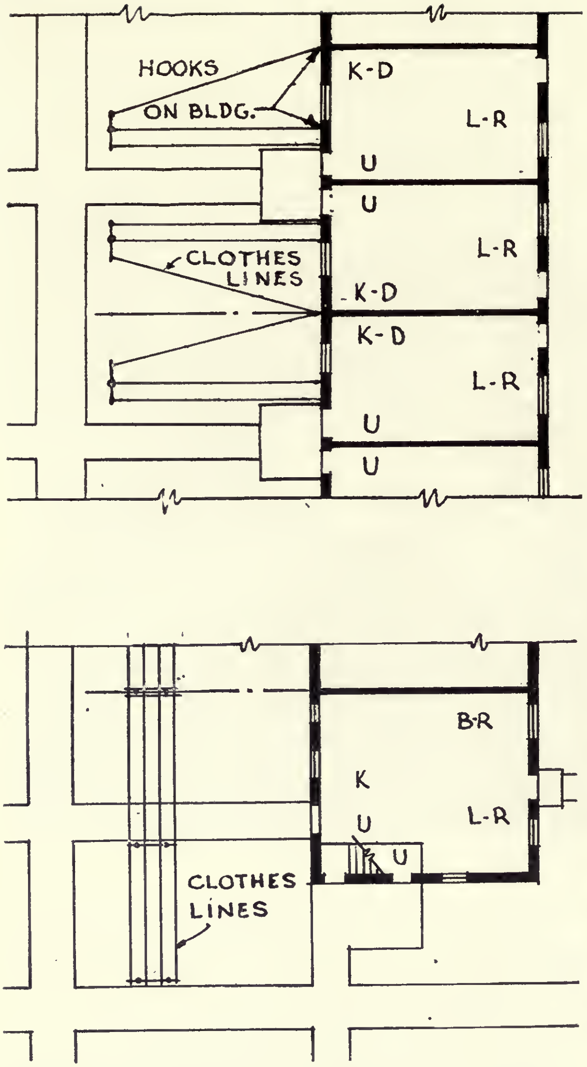
5. About 24 or 25 feet is the maximum satisfactory span for rope lines.

> 35 foot lines are too long—tend to sag. — Florida

6. Hooks in the house wall should be set at least



Posts should be set well back from approach walks for general appearance and to keep the clothes from flapping on passersby



Arrangements of posts and lines that have proved satisfactory in tenant yards

18 inches apart, if lines from these hooks converge at a single point. If lines are parallel they should be not less than 12 inches apart.

> Laundry Drying: Hooks on houses for lines are only 8 inches apart, so clothes can't dry. — Virginia

7. The height of line should be about 6 feet 6 inches above grade. This is too high for some women but is necessary to allow for sagging of lines. (Height may be reduced to 6 feet if a convenient place for storing clothes line props is available.)
8. Open hooks have proved satisfactory and have been generally used. Reels have obvious advantages but are relatively expensive.
9. Demountable folding and revolving driers have the great advantage of allowing a housewife to stand on a paved walk and hang out an entire wash; under certain conditions their provision is warranted, but they are expensive, subject to damage, and require storage space.

> The use of whirligigs at projects has not proved satisfactory inasmuch as they are too heavy and awkward for most tenants to carry and if they are removed there is no place to store them. Consequently whirligigs are left, for the most part in the sockets, opened. The arms become broken and the ropes have to be replaced. We would suggest the elimination of whirligigs and the substitution of posts with arm brackets or an arrangement so that clothes lines could be hung from a hook in the exterior wall to a wood clothes post. — Pennsylvania

A paved approach to lines saves lawns

10. A paved approach to at least one length of line is wanted by housewives, who sometimes sink ankle deep in a newly planted lawn after a rain or thaw. Some managers recommend placing one line parallel and close to the approach walk to the kitchen door.

COMMON LAUNDRY DRYING YARDS

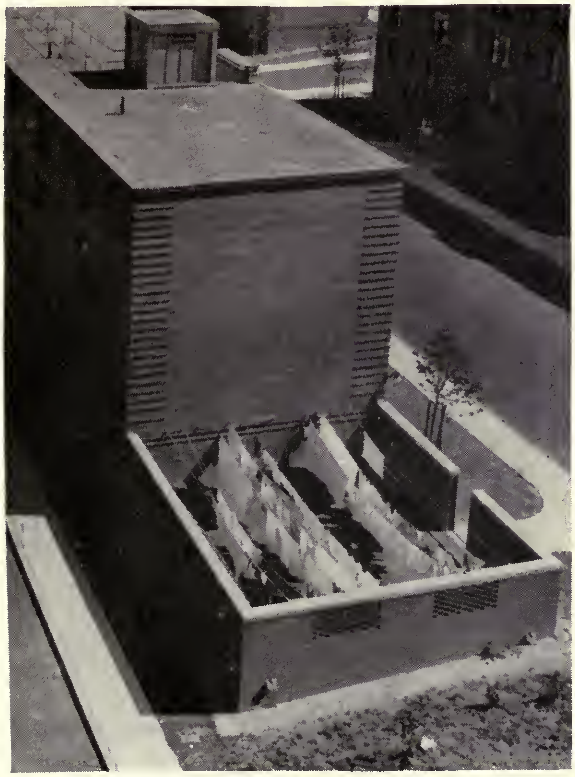
In projects with central laundries the yard should be located near the entrance to the laundry. Where no central laundries are provided, the yards are preferred near the entrances to the buildings which they serve. Since the use of lines is on a scheduled basis, the most desirable exposure to the sun and prevailing breeze should be arranged. In practice, however, this rule has often yielded to considera-

Common drying yard protected from an adjacent play area by a chain link fence

tions of appearance, and all sorts of planning devices are used to conceal the yards or to isolate them.

Frequently play yards have been placed close to drying yards, so the children can play there while their mothers are hanging out the wash. Some dissatisfaction with this arrangement has been noted where sandboxes have been provided in these play yards. In some cases it has been decided that either the laundry yard or the play area must be moved. Removal of sandboxes from the play yard, however, and provision of fencing around the laundry yard usually reduce problems arising from this relationship. Proximity to incinerators is not good, either: in spite of spark screens, soot and charred paper will drift down.

Common drying yard in a prominent location concealed by a brick wall

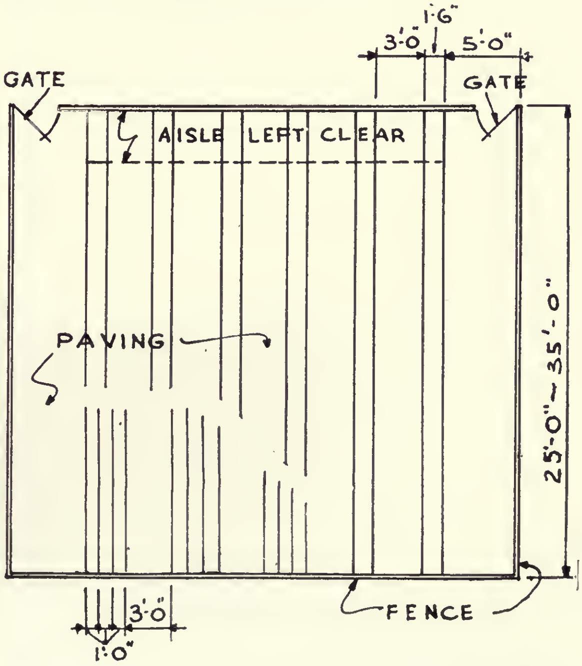


The space required varies with the length and the spacing of the lines. Where there are no indoor facilities, or where these are limited, space for 12 feet of line per family is reported to be a reasonable minimum for yards serving dwellings with an average of less than two bedrooms each. 15 feet is required for larger units. When outdoor lines supplement adequate indoor facilities, however, 8 to 10 feet per dwelling is sufficient.

Some suggestions on posts, hooks and lines for common drying yards are given below:

1. Lines should be 12 to 18 inches apart, with 3 foot aisles between groups of two to four lines.
2. A maximum of 35 feet between supports is advisable for wire lines, 25 feet for rope lines.
3. The rules given for proximity of lines to buildings, walks and fences in private yards, apply also to common drying yards.

Satisfactory arrangement of lines in a common yard



4. In calculating the size of the drying yard, allow for a space 3 feet wide at one end of the lines for access to the aisles. In large yards, allow also for 3 foot spaces for cross access to lines, at not less than 35 foot intervals. These spaces may be indicated by marking on the yard pavement or by clips on the lines.
5. Project-owned lines are generally more satisfactory than tenant-owned lines. Tenants often place their own lines before scheduled time and allow them to remain when the time has expired, with resulting disruption of schedules.
6. A hard surfacing and a paved approach are essential.

> There have been definite demands to provide walks to all drying yards. — Regional Report

7. Fencing affords some protection from playing children and reduces the danger of theft. A high fence (6 feet) planted with vines can be used if screening is desired; a low fence (3 feet or 3 feet 6 inches) permits better visibility and circulation of air.

The Ground Surface

The important relationship between grading and the component parts of the site plan has been touched upon in preceding parts of this chapter. This section is intended to stress significant details and to impress upon the site planner further the necessity for the skillful handling of this phase of site planning—the third dimensional one—which has proved to be the least well-handled. It seems appropriate, therefore, to point out a series of the more important factors; things to be done, things to be avoided, and things for which there are no rules, but which merit thoughtful attention.

The purposes of grading are to create economical and convenient building sites; to carry off surface water at a minimum of cost, of inconvenience to tenants, and of damage to project; to fit each part of the site to its proposed use; to reduce the cost of grounds maintenance; and to lend a pleasing appearance to the project.

The basic data essential to the preparation of a grading plan include an accurate topographic survey, supplemented by borings, and the location and elevations of existing on-site utilities and easements.

A reasonable balance of cut and fill favors economy. Where rock- or water-bearing sand is encountered near the surface, however, considerable fill may reduce the costs of utility trenching. Fill usually simplifies drainage design and reduces the amount of storm sewers.

When streets are more or less perpendicular to both buildings and contours, surface water should flow to the street along swales on the uphill side of each row of buildings.

When streets are parallel to both contours and buildings, the flow should be to the street between the ends; the high point being near the middle of the building with a swale in each direction carrying water toward the ends.

On very level sites, road grades should be set as low as practicable, and cut material used to raise the grade around the building. Wide swales are used for surface drainage, so far as practicable, as a substitute for storm sewers and drain inlets.

Heavy fills around buildings and under pavements should be avoided, though it is recognized

Banks and steps near dwellings are hazardous and costly to maintain

High retaining walls and steep banks must be protected by fences or other barriers

Horizontal grade lines along the faces of buildings do not always work out to advantage

that heavy grading operations are sometimes justified. Deep fills should be confined to playground sites or other open areas. Creation of high steep slopes, which are invariably unattractive and difficult to maintain, should be avoided.

Horizontal grade lines on the faces of buildings are sought for appearance and to avoid stepping of footings; in practice, however, this does not always work out to advantage. Even though a sloping grade line may require stepped footings, it may have these compensating advantages: improved drainage; reduced slopes from building to walk; reduced slopes between ends of buildings; and improved appearance by reason of better relationship of buildings to the general form of the site. To permit free use of sloping grade lines, the building plan must be capable of adjustment with regard to steps and grade-to-floor heights.

Grading of all areas should be adapted to their functions, and with a view to the character of soil, climatic conditions and local custom. Subject to adjustment for these special conditions, the following gradients are suggested:

1. Lawn areas should slope at least 1 percent. 25 percent is maximum for use of lawn mower. Slope of tenant yards ranges from 1 percent to 10 percent; part of the yard should be level.
2. Swales crossing walks should have a 1 percent normal minimum gradient, with 2 percent preferred; the maximum will depend upon intensity of rainfall periods and area of runoff; swales carrying the runoff from half an acre will often erode if the grade exceeds 5 percent; for smaller areas 10 percent is sometimes practicable.
3. Banks should never have a slope greater than their natural angle of repose—which varies widely. So far as ease of maintenance is concerned, a 3 to 1 slope is reasonably desirable, and 2 to 1 the maximum.
4. Paved laundry yards should slope at least 0.5 percent for quick drainage, but should not exceed 5 percent unless there is little or no snowfall.

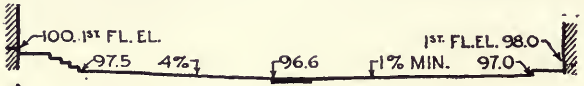
5. Playgrounds should have only the minimum slope for drainage, dependent on the type of surface. Paved surfaces which are slippery when wet should range from 0.5 percent to 2 percent; gravel is not practicable above 3 percent; grass has some usability at almost any grade, but few organized games can be played on a slope greater than 4 percent.

Symmetrical building groups fail to attain their intended effect if the grading does not carry out the same intention. Symmetrical malls should not be graded with a transverse slope; the long straight approach to an important building should not be given a hill-and-valley profile.

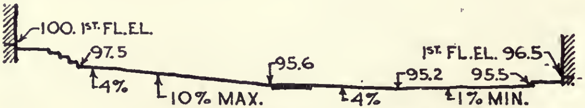
Unnecessary slight cuts in the grade reduce the agricultural value of the soil nearly as much as deep cuts. Shallow fills are not so damaging and they favor rapid growth. Topsoil should be conserved to the greatest extent possible, and what is saved should not be damaged by admixture of subsoil or building debris, or by trucking over it.

It is desirable to preserve existing trees and other growth of value. Even trees that may be saved for only a few years, without becoming a hazard, are worth preserving. Many projects bear eloquent testimony to the fact that nothing can do so much to lend a pleasant atmosphere to a housing project as a few large trees.

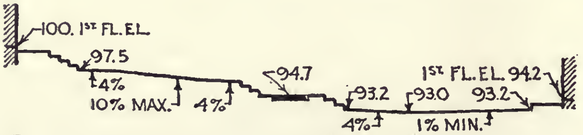
A few large trees lend a pleasant atmosphere



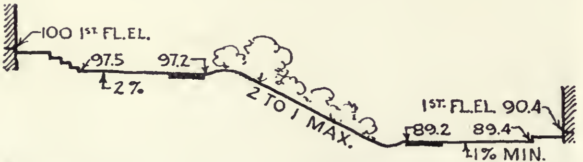
A. CENTRAL WALK AS DRAINAGE CHANNEL; PREFERRED FOR MODERATE SLOPES.



B. CENTRAL WALK AND SWALE AS DRAINAGE CHANNELS, SOMETIMES NECESSARY ON MODERATE TO STEEP SLOPES.

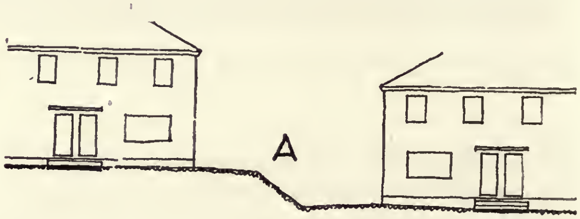


C. CENTRAL WALK, STEPS, AND BANKS; SOMETIMES NECESSARY TO AFFORD MAXIMUM YARD SPACE ON STEEP SLOPES.

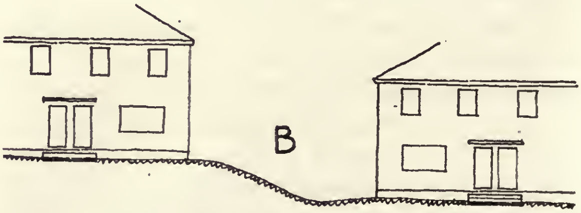


D. PARALLEL WALKS AS DRAINAGE CHANNELS; SOMETIMES NECESSARY ON VERY STEEP SLOPES.

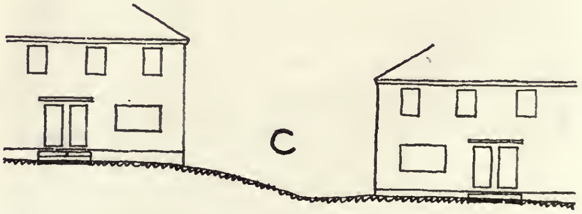
Many satisfactory variations in grading between parallel buildings are possible



AVOID THIS



SOMETIMES NECESSARY



PREFERRED

Grading between ends of buildings merits special attention

Outdoor Recreation

PRELIMINARY PLANNING

Play spaces, properly designed and located, tend to reduce accident hazards to children.

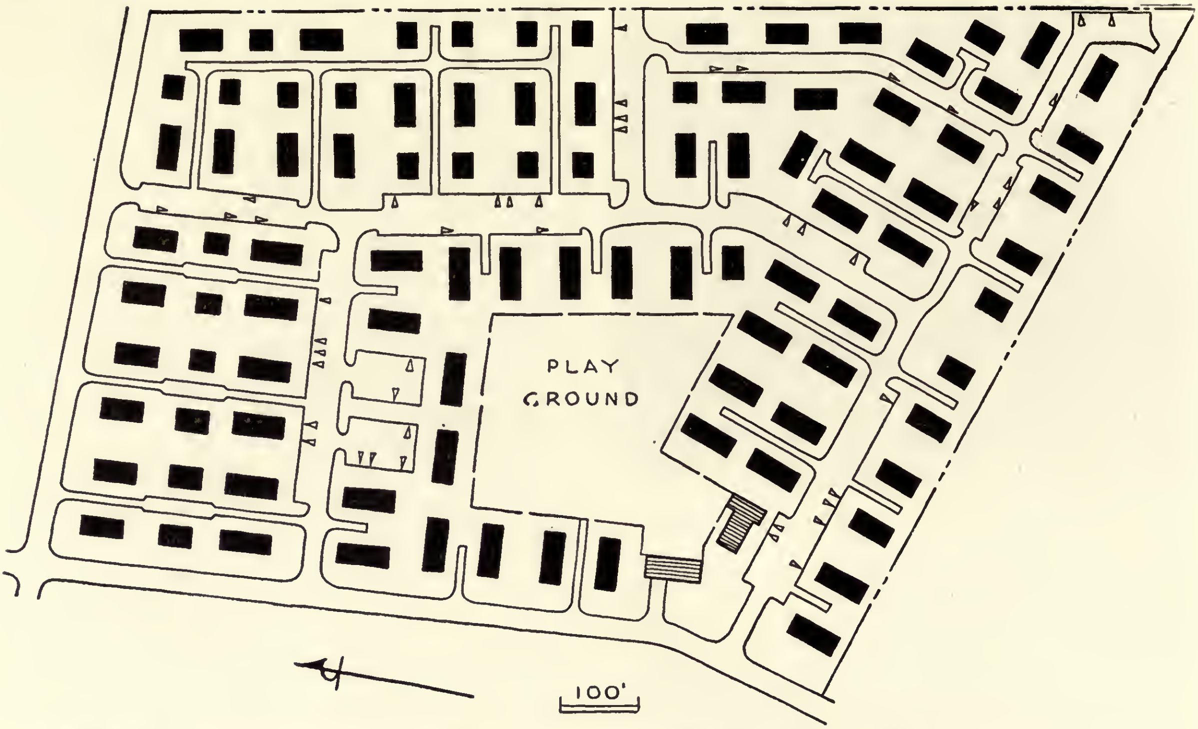
The amount of space that is required for play use on the site, calculated according to project size, is set forth in the "Minimum Physical Standards."

Decisions as to the types and number of areas into which this space shall be divided and as to where these areas shall be located must be made early in the organization of the plan. These decisions will be influenced by the type of buildings used, by the topography of the site, by soil conditions, by relation to specific features in the neighborhood (notably existing recreational facilities) and by other elements which affect the plan.

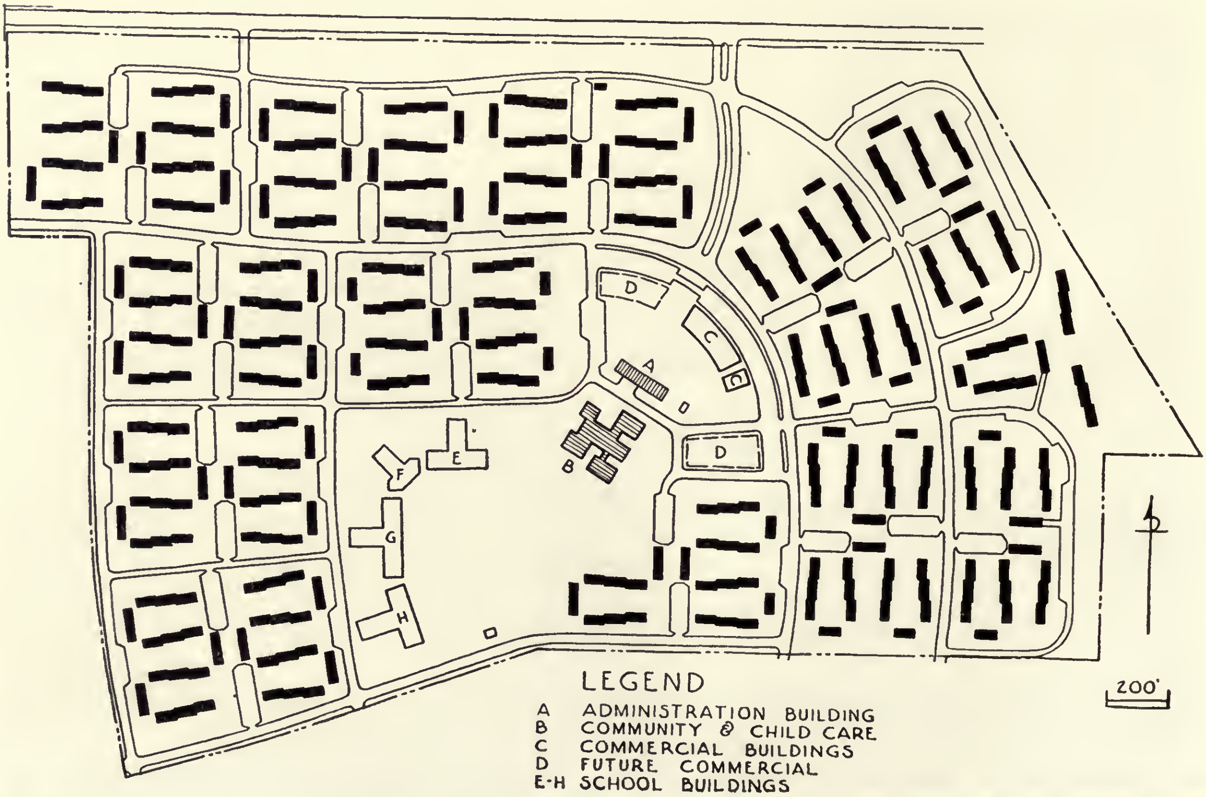
One good rule to follow, where space for organized play programs for school-age children and adults is to be provided, is to combine all of the space, or as much of it as is practicable, into one area, and to develop it as the principal play area of the project.

This rule has such definite advantages over a scheme in which the same amount of space is subdivided into two or more parts that it should be followed wherever possible. One advantage is that a greater variety of games can be played on a relatively large area than on several small ones. The

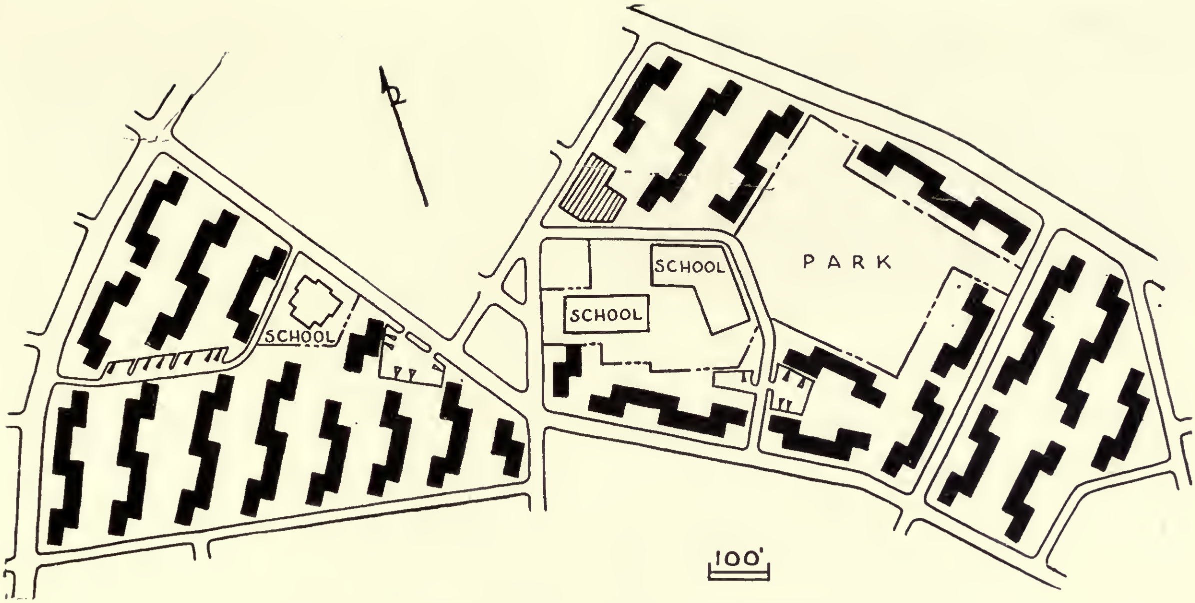
Play spaces properly designed and located tend to reduce accident hazards



One large area—the principal play area—permits a diversity of play and easy supervision and favors economy



An example of good relationship between the principal play area, the community buildings, and the dwelling units



Public playgrounds or small parks are sometimes included within the boundaries of a project

large area is, therefore, more satisfactory from the point of view of the people using it.

> If a child is given a good home, without being given also enough place to play, he is going to feel mistreated. Boys, especially, need a chance to play traditional American games. — Alabama

Another important advantage is that one area, particularly one large enough for a diversified play program, is more easily supervised than two or three areas which are located at some distance from each other. A further consideration is economy. Convenient access to toilet facilities and storage space for playground equipment is essential, and proximity to play rooms, craft rooms and a recreation director's office is desirable for all play areas where a supervised recreational program is provided. The provision of two or more areas implies duplication of these facilities.

More than one play area for organized programs is, as a rule, satisfactory only on sites where part of the dwellings are separated from the project center by a hazard of some kind, such as a traffic artery, or by a distance greater than children can reasonably be expected to walk. In such cases, the greater portion of the total amount of play space required should, nevertheless, be developed as the principal play area, and the remainder planned as one or, if necessary, two or three subsidiary play spaces. The latter should be located near the groups of dwellings separated from the principal play area.

The desirability of locating the principal play area at the community building has been mentioned earlier in this chapter. Locations to be avoided for all play spaces are land adjacent to churches, hospitals, or libraries, and land bordering special hazards, such as a traffic artery, railroad right-of-way or river bank, unless adequate protection is provided by means of high fences.

Since responsibility for supervising playground activities is normally assumed by local public recreation agencies, their aid should be secured in this phase of planning. This help is particularly important in connection with the design of play areas intended for organized play programs, playgrounds for older children and for adults, child-service play yards, and other areas that require trained supervision for satisfactory use.

A number of housing authorities have made arrangements with public recreation agencies whereby all or part of the recreation areas needed for the project school-age children and adults are provided by the agency, either adjoining the project site or nearby. In some instances, public playgrounds or small parks have been included within the boundaries of the project.

Occasionally, housing authorities, by agreement with recreation officials, have allocated some land

A general play area

within or adjoining the site as a public playground or as an extension of an existing inadequate playground bordering the site. New schools have been built next to, or within, the boundaries of a few isolated projects. In several such cases, housing authorities, by agreement with school officials, have allocated land adjoining the school buildings as a playground, with the understanding that the playground may be used by all school children.

Special play area for court games

Special play area for crafts

TYPES OF RECREATION AREAS

Various types of recreation areas have been used to meet the play needs of all age levels. They may be classified in general under four broad categories, which, together with their various subdivisions, are briefly defined as follows:

1. Principal recreation area: This is the largest and, in most projects, the only space provided for organized games and for activities which require special equipment or trained supervision. It is usually subdivided into a general play area and special play areas.

   The general play area is used for ball games, such as softball and dodge ball and other games popular with school-age children and adults.

   The special areas are used for: (1) fixed playground equipment, (2) court games, (3) water play, (4) play program for small children, (5) outdoor parties and dances, and (6) table games, crafts and story telling.
2. Secondary recreation areas: these are planned to meet special play needs which are not met by the principal recreation area. They include general, special, and local play areas.

Special play area for program of small children

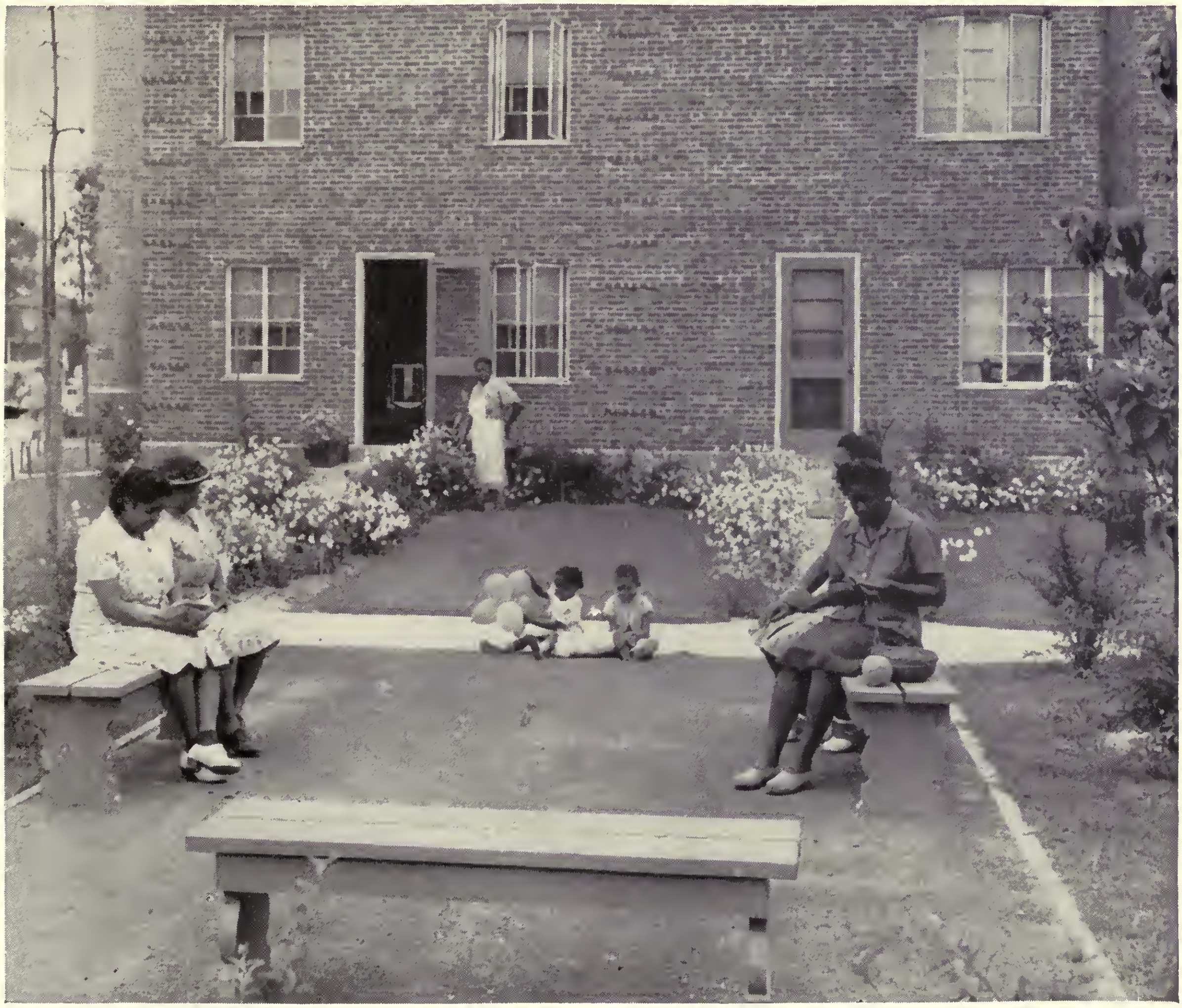
A secondary general play area is usually provided when part of a project, 50 or more units, is separated from the principal recreation area by extreme distance or by a special hazard.

Supplementary special play areas, which are sometimes provided away from the principal recreation area, include play yards for child-service centers, water play areas or game courts.

Local play areas consist of open spaces for play close to groups of dwellings. They include (1) play spaces for pre-school children, usually provided only where individual tenant yards are lacking or are not suited to the play of small children, and (2) areas for informal recreation by all age groups; these are liberally used in apartment and other high density projects which lack private tenant yards adapted for family use.

A paved local play area

3. Sitting areas: paved spaces provided with benches, primarily for the use of mothers with infants. They should include space for parking baby carriages and some space in which very young children may play.



Sitting areas afford opportunities for outdoor reading, needlework and informal conversations

4. Miscellaneous recreation areas: These are spaces within the project which may be developed without special cost for the use and pleasure of tenants, but which are not adapted for general recreation:
    - a. Streets, closed to traffic, but with the paving retained.
    - b. Slopes, too steep for building.
    - c. Areas with pleasant and usable natural features.

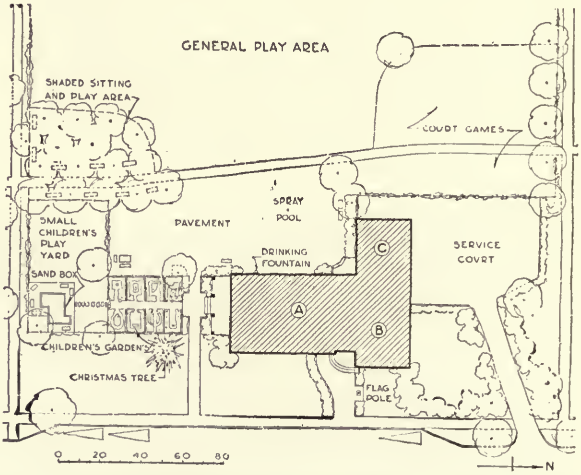
DESIGN OF PRINCIPAL RECREATION AREA

The more important points to be considered in planning this area are discussed below:

1. Slope and drainage: The slope should not exceed 3 to 4 percent; good drainage is essential.
2. Relation to community building: Assuming that this area is located adjoining the community building, as previously recommended in this section, the special play areas (except large game courts and space required for fixed playground equipment for children of school age) are preferably concentrated near the community building. A location directly outside the windows of the management offices, however, should be avoided. If the principal play area is not located at the community building, a shelter consisting at least of play rooms, toilets and storage space should be provided.

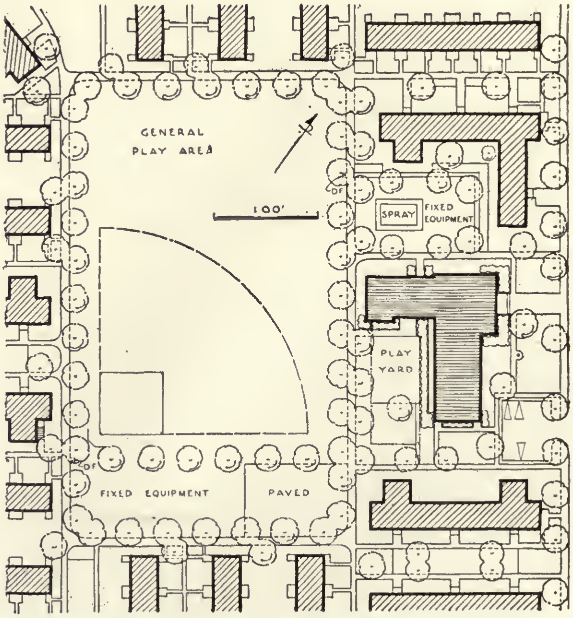
    The arrangement of spaces and equipment near the community building should permit convenient access to social rooms and toilets from all parts of the play area. Proximity to play rooms and toilets is particularly important for the small children's play yard.

    A paved terrace at the community building, designed for outdoor parties and games, as hopscotch and shuffle board, is frequently used as a



Study of principal play area on project of moderate size

Lawns and established trees invite informal play



Layout of principal play area on a large project means of access to the building from other play spaces.

3. Organization of the area: A plan which keeps free as large a general play area as possible is usually preferred by recreation directors to one in which the continuity of the area is interrupted by any features, as fixed playground equipment, walks or benches which would interfere with its usability for organized games—ball games, and other activities requiring a considerable amount of space. Except for the small children's play yard, which is usually fenced, the spaces provided for special activities need not be separated from each other, or from the general play area, by barriers. Their usefulness is frequently increased when the spaces required for two or more kinds of activities are combined or when they are planned for a certain amount of overlapping.

   The total open space for general play purposes, for example, can be increased by combining a large game court, planned for basketball and volleyball, with the general play area. An extension of the paved border around a spray pool may form a fine roller skating circuit and, if properly proportioned, it can be used also for various kinds of court games, such as shuffle board and paddle tennis.

   Many recreation directors recommend grouping all pieces of fixed playground equipment for children of school age in one part of the playground in order to permit easy supervision. A location along the side lines is usually preferred to a more nearly central position.

Location of fixed equipment along side lines is usually preferred

Direct access to play yard from rooms used for small children is desirable

Above: useful terrace at entrance of community building
Below: spray pools are often used for wheel toys

The location of the water play area requires careful planning. It should be kept far enough away, at least 30 feet, from building walls, walks, and other play facilities; otherwise, the spray blowing against them may constitute a nuisance. Locations which will tend to create maintenance problems should also be avoided, such as on filled ground, which may settle, and in flow areas where drainage from an adjacent slope may run into the spray pool.

> Keep sandboxes away from spray pools. — Washington State

The spray pool should be near the small children's play yard, but preferably not located within its boundaries. Occasionally, however, a small spray pool may be provided in the play yard for the exclusive use of the small children.

A favorable exposure for both the spray pool and small children's play yard is desirable.

A quiet space, either paved or grassed, near the community rooms is liked for crafts, storytelling and table games.

4. Special design considerations: The principal play area should be so proportioned that a ball field and courts for popular games can be efficiently laid out and favorably oriented. Space for benches along at least one side of the major game courts is recommended by some recreation directors.

Some shade is essential. Well-established trees on the perimeter, and other existing trees which do not interfere with the usability of the area, should be preserved. If there are no such trees, trees should be planted to afford shade where it will be needed. Young trees need protection, however, if they are to survive.

A boundary fence is necessary if the area borders tenant yards, or walks, or any feature offering a special hazard, such as a street, parking lot or railroad right of way.

Game courts, both paved and unpaved, are more useful if planned for a variety of games than for special games only.

The play yard for small children should be planned so that the items of equipment usually provided may be placed to minimize hazards both to the children and to passers-by. Soft surfacing under the equipment reduces danger of serious accidents. Hard surfacing is usually recommended for about 20 percent of the small children's play yard. Nursery school specialists suggest that this percentage is sufficient to permit

Young trees need protection if they are to survive

Well placed equipment in a play yard for small children

a paved terrace for varied play use and a perimeter walk for wheel toy play. Turf is preferred for the remainder of the play yard, where practicable; tan bark has also been satisfactory. A digging strip at one side of the yard is desirable, also a space suitable for small gardens. Shade is essential. Frequently temporary shade is provided by means of quick growing vines, supported on a trellis.

Facilities for water play usually consist of a spray pool and paved border, in preference to a wading pool. Spray pools are safer, more sanitary, less expensive to operate and maintain, and easier to supervise than the wading pools. Spray pool designs vary according to the preference of the designer and to specific local conditions. Curved forms are preferable to angular forms which collect sediment. The pool should have a paved border not less than eight feet in width, in order to prevent mud puddles and ensuing maintenance difficulties around its edge. Details of construction and types of pavements recommended are discussed in "Site Engineering." Occasionally a well drained pavement with a water outlet nearby has been converted into a water play area by means of a portable spray. Space for benches is desirable.

Benches should be provided near spray pools for the convenience of parents who wish to supervise their children. — Maryland

Spray pools require a paved border

DESIGN OF SECONDARY PLAY AREAS

Secondary general play areas are preferably planned according to the recommendations for the principal play area. Since they are not near the community building, a shelter with toilets and storage space for playground equipment is usually necessary, and for areas which serve 100 or more dwellings, a play room, craft room and recreation director's office are desirable.

Supplementary special play areas: play yards for child-service centers, spray pools, and game courts, are also preferably planned according to the recommendations for those located at the principal play area.

Local play areas are useful for informal play for small children and for other members of the family. Such areas require especially careful planning.

Open spaces between buildings, whether paved or not, are useful to older children and adults where the dimensions are suitable for popular court games, such as croquet, badminton, horseshoes.

Some turf is desirable for areas intended for small children but it should be supplemented by a smooth paved space for wheel toy play. Designation of a special place where children can dig is recommended by some managers. Some shade is essential. A temporary shelter is acceptable if no shade is available otherwise. Sandboxes and simple climbing equipment are sometimes provided, and are satisfactory where competent supervision is provided by mothers or by recreation leaders.

Children tend to avoid very small, unshaded, unequipped, hard-surfaced areas, sometimes labeled "pre-school play areas" on the project plans.

> Is that what those paved areas are for? I always wondered! I've never seen a child on one of them in the year I've been here. — Kentucky
>
> Children want something to do; space, just empty space, doesn't mean a thing to a child. — Wisconsin

Without some supervision, however, even simple equipment may create problems.

> The sand gets scattered and causes maintenance problems. — Georgia
>
> The big kids use the small children's equipment and break it. — Tennessee

Combining sitting spaces with the play areas helps to assure a certain amount of supervision.

DESIGN OF SITTING AREAS

Sitting areas should include small plazas at com-

Sitting areas increase the livability of apartment projects

Shade adds attractiveness to sitting areas

munity buildings but also should be distributed throughout the project where they will be enjoyed most.

They are most useful if located directly adjoining the outside entrance of apartment buildings, or placed near a public walk leading to a group of row houses or flats, or where they afford a fine view.

Some grass, earth, and paved spaces on which small children can play are desirable. Space for benches and for parking baby carriages is essential, Lighting for evening use should be provided.

> It is the local authority's feeling that benches are especially needed in projects of the three-story apartment building type. — Pennsylvania
>
> Sitting areas remotely placed and connected by small paths means wearing of grass areas. Recommend sitting areas directly off main paths. — Pennsylvania

MISCELLANEOUS RECREATION AREAS

These areas take advantage of latent features in the site that can be developed at little cost for the special enjoyment of the tenants. For example, closed streets are sometimes converted into roller skating rinks or court game areas; a path leading to the summit of a steep slope may afford a fine view; or a path cut through a wooded area may be developed into an attractive walk.

Ravines and other areas not suited for building purposes have occasionally been converted into picnic grounds at relatively slight expense by the addition of an outdoor fireplace and picnic tables. Installation of a water outlet nearby is desirable as a protection against field fires, and is also a convenience to picnickers. Toilet facilties are desirable for areas located at some distance from dwellings,

A fine view is afforded from this bench and shelter

and a simple shelter for protection from sudden showers is an asset. Good lighting for picnic areas is reported necessary, particularly in wooded areas, both to increase their usefulness and to permit effective supervision.

LOCATION OF FIXED PLAYGROUND EQUIPMENT

The installation of fixed playground equipment is not ordinarily a part of construction contracts, but all play areas in which equipment is likely to be installed should be designed to permit an arrangement of the various pieces which will (1) reduce the danger of accidents, (2) avoid breaking up the continuity of a large open area, (3) permit convenient supervision.

Representatives of the agency expected to provide supervision should be consulted as to the types of equipment for which space will be required. A detailed plan for the proposed development of the play area should be prepared, showing the intended location of each item of equipment in order to insure the allocation of adequate space for its use.

Types of playground equipment which have been provided include various kinds of climbing apparatus, slides, swings, sandboxes, and occasionally, seesaws, merry-go-rounds, or giant strides. All of these are reported to be satisfactory, if properly designed, constructed of durable materials, correctly installed, and used under competent supervision. Some types have created problems, however, when used by children without supervision. In a number of proj-

Basketball equipment on a general play area

Concentration of fixed playground equipment simplifies problems of supervision

ects managers have found it necessary to remove some types of equipment such as swings and high slides because of accidents to children.

Sandboxes have been eliminated from unsupervised play areas in many projects, because of the practically insurmountable difficulty of keeping them in a sanitary condition and free of broken glass and other debris. Where sandboxes are provided, recreation directors recommend that they be located away from drinking fountains, but that a water faucet be provided nearby for convenience in dampening the sand.

In order to simplify the problem of supervision, most recreation directors prefer to have most types of fixed playground equipment concentrated at play areas large enough for a general supervised play program. Pieces for the use of school-age children are therefore usually located on the principal recreation area, and on secondary general play areas, if provided. Equipment for preschool children is usually placed in a special play yard at the com-

Supervision is frequently provided by tenants

Masonry walls are popular as play equipment

Small children need low fountains

munity building or at a separate child-service building.

The desirability of locating pieces of equipment along the side of a play area rather than in a more central position (already mentioned in connection with the design of the principal general play area) applies to equipment for all play areas.

Low masonry walls, simple sculptures and other sturdy structures have been provided by several housing authorities to supplement conventional fixed playground apparatus.

OUTDOOR DRINKING FOUNTAINS

Drinking fountains are a necessity and should be available to all play areas, except small local areas. Their number and location must, of course, be judged in the light of general site conditions, for example, the layout and population of the project. It is desirable that fountains be set on a paved area five to six feet in diameter. Unless special fountains are provided for the use of small children, steps are necessary. Particular consideration should, of course, be given to the type and details of the fountains to insure sanitation and to discourage damage by children.

OUTDOOR LIGHTING

All play and sitting areas require some light to permit supervision at night. Floodlights for part of the principal play area, particularly the game courts, are strongly recommended by many managers and recreation directors.

Children enjoy play sculpture

The Dwelling Type: Project Density

It is recognized that all of the criteria relative to selection of dwelling types[1] mentioned in the "Minimum Physical Standards" cannot be met completely on any one project. Since many factors in the problem may be in some degree opposed to a number of the others, a well-balanced compromise is often the best solution that can be obtained. For instance, dwelling types which lend themselves naturally to the physical nature of the site may not be well suited to the special needs of the tenants; types which are best fitted to the general economic level of the tenants may not be in accord with the zoning regulations in effect, or may be incongruous with the existing neighborhood pattern or its trend.

Many such conflicts between the several factors might be cited. Moreover, there are no rules whereby any single criterion can be met with assurance that the right answer has been found. In this respect the selection of dwelling types is quite different from other things treated in the "Minimum Physical Standards", such as required room sizes (which can be expressed in square foot areas) essential equipment, and so on.

All of the factors listed, however, have proved significant and worthy of full consideration in this phase of project development. Hasty decisions or rigid adherence to preconceived ideas as to types of housing may not only jeopardize the success of a project but may work an injury to the orderly and proper development of the community of which it is a part.

For example, land cost may suggest a certain density which, in turn, will demand, or at least favor, dwelling types producing such a density, while at the same time quite different types may be more suitable to the site's topography and to the tenants' needs. Consideration of an appropriate balance among all these interwoven factors should, if necessary, lead to reconsideration of sites tentatively selected or even, in some cases, to abandonment of all of them in favor of others still to be located.

To aid the housing authority in this undertaking and to provide the basis for reasonable confidence that a satisfactory, if not perfect, answer will be found, the FPHA can only discuss in the light of its past experience the various points to be resolved. Such references as are made to specific projects are cited merely as illustrations, and may ignore unknown but weighty factors which have influenced type selection. Hence, the comments should be considered suggestive only in their application to the new projects contemplated.

For final decisions, the housing authorities and their experts will have to depend upon a complete analysis of the local problem supported by sound knowledge of the fundamentals involved. That local opinions vary is evident from such comments as these:

> The Association recommends to FPHA that single and twin houses (desired by most families, and producing high degree of tenant maintenance) be used in as large numbers as is consistent with development and management costs—and with consideration to desire and need of some tenants to be free of maintenance responsibilities. — Association Report

> A study of nearby projects indicates that these projects should be of small group houses, preferably twin and not more than four dwelling units per building. — Regional Report

> Proposed type of structures are one-story detached single units; one-story semi-detached double units; and two-story row houses varying from six to nine

---

[1] The names given to various dwelling types in this review are those which have commonly been used in the past and which are generally accepted in most but not all localities. Thus, for example, what are referred to here as "twin houses" are sometimes termed "semi-detached houses", and "flats" (used here to designate small dwelling units so arranged that the access hall or stairs are incorporated in the dwelling and maintained by the tenant) are often called "apartments". For statistical purposes other definitions are used.

One-story twin houses are often suitable on outlying sites

units per building. The number of units of each will depend on the site selected. — Virginia

On the sites near-in, structures containing six or eight dwellings seem advisable. On the sites on vacant land, doubles, triplicates and one-story courts are being considered. An attempt will be made to get away from the institutionalized effect of row houses. — Colorado

From experience the local authority has found that the group or apartment type is most suitable for construction because of restricted cost. On the other hand, the authority would be disposed to erect detached or single dwelling units to the extent that funds advanced by the Federal Government would permit such construction. This is essentially a matter of development cost. — Louisiana

The experience of the local authority has proved that the group house type of apartment building is more economical and more easily maintained than single or duplex units. — Texas

Row houses generally predominate on sites in areas of moderate density

RELATIONSHIP BETWEEN LAND COST, DWELLING TYPE, AND DENSITY

Density[1] was a controversial subject when federally-aided, low-rent slum clearance housing was started, and still remains so. Experience, which has settled many problems incident to public housing, has only provided indications toward the solution of this particular one. Decisions in this field have often depended more upon emotion than upon pure reasoning.

There is a widespread feeling that human well-being, so far as housing is concerned, increases in direct proportion as housing density decreases. At all events a preponderance of argument is in favor of low-density projects when the subject is discussed in general, rather than specific, terms. "A place in the suburbs where Junior can have a dog and we can have a little garden," "Every American family has a right to some space where it can breathe and expand," and, "The automobile has made it unnecessary for people to live in crowded, unhealthful, apartments like rabbits in a warren." Statements such as these are frequently made by people to whom the detached house set in the midst of a generous plot of ground is not only desirable but necessary to the American way of life. They may accept a twin house as a compromise or, under protest, a row house if yards are provided and the number of dwellings to the acre is not high. But they will never agree to the high-density multi-story apartment.

> Based on past experience, this authority would not favor the erection of row houses with twelve to fourteen units per building. The design should be such as to fit in with private construction and add to the appreciation of the localities where the projects are located. — Pennsylvania

> It is suggested, where possible, that small buildings be constructed, that is, semi-detached and small group houses. Small buildings tend to add more individuality to the unit as a home. — Texas

> Row dwelling units of one-story type (four units each) are considered acceptable for slum clearance projects, but greater density is not considered acceptable. Duplex (twin) one-story units are preferred, arranged for more definite division of yard areas. — Alabama

On the other hand the proponents of the high-density type of public housing project may argue with some degree of emotion: "Tenants in public housing are hard-working city folk; they have neither the time nor the inclination to fuss around with gardens; they want to be near the bright lights, the movies, and their places of employment," or, "This is purely a matter of economics—if you want to rehouse these families on the expensive sites of present slums, you have to pay the price; and that forces projects of high density." Which is quite true, of course, provided that none of the land cost can be written off; the question becomes one of how high the density may go and still be justified.

> In order to achieve greater ground space between structures, it may be necessary to construct buildings four or more stories in height. The planning of such structures may prove to reduce the over-all construction cost per dwelling unit below the cost of dwelling units in structures two or three stories in height, and at the same time provide more adequate outdoor space for the development of recreational facilities and be more in keeping with the concepts of modern planning. — Connecticut

> Due to the difficulty of obtaining land and the large number of dwelling units needed, the density should be increased, some of the buildings should be designed four stories high. — Puerto Rico

> The authority has already developed two multi-story apartment projects on high-cost land in slum areas. This is a pattern that will have to be followed because the land will have to be made available by clearing present slum sites. — California

Experience shows that unquestioning acceptance of either extreme unsupported by sound reasoning in each specific case is detrimental to sound project development. Projects of very low, and of very high, density have been justified. The success of a particular project depends not alone on the density chosen, but on the proper relation of that density to all the other factors. Some of the more significant conclusions from FPHA experience are summarized in the following paragraphs.

Most of the low-to-medium density projects developed up to this time have resulted in a high degree of tenant satisfaction. A very large proportion of these projects are of the row house type, frequently in combination with a few flats. These types produce densities somewhere between the detached or twin house and the apartment. Even in

---

[1] Density, as the term is used in this review, means net density, the number of family dwelling units per acre, excluding public streets, large recreation, unbuildable or reserved (excess) areas, and the land covered by and associated with nonresidential buildings.

The row house has been widely used and accepted

localities where it is an innovation, the row house meets little public opposition. Some communities, however, dislike this dwelling type; and, in any event, it is not the best solution in all cases.

The compelling need, in many cases, for direct slum clearance rather than for clearance through equivalent elimination entails high land costs, which, in turn, will impose relatively high densities if total development costs are to be kept at moderate and justifiable levels.

It is not always wise to assume that density must be in direct ratio to land costs. Much housing experience may seem to substantiate such an assumption; but if followed as a hard and fast rule it could readily lead to errors if land costs are very low or are extremely high.

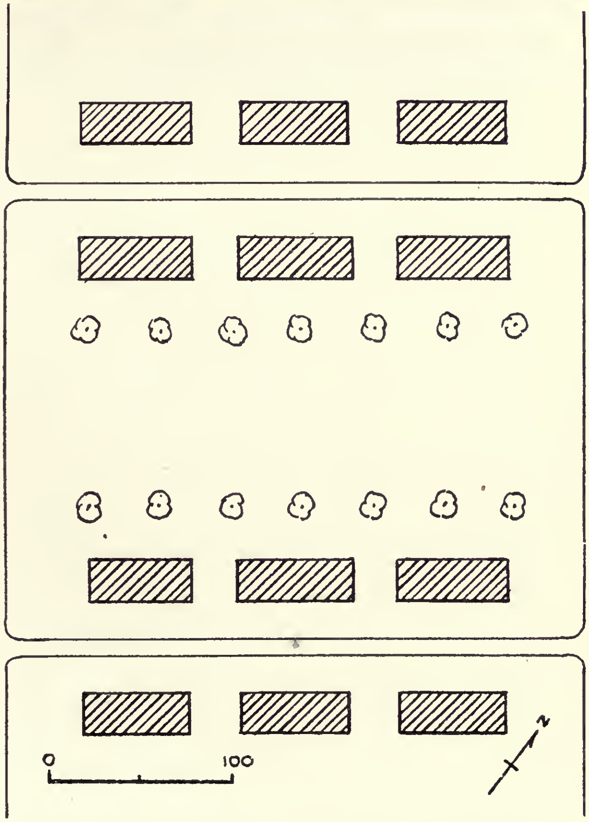
The determining factor in establishing density may be neither land cost nor the influence of present neighborhood conditions; rather, it may be consideration of trends in the general area of the site, as indicated by recent changes or by local plans for long range urban and regional development.

The relationship of project density and land coverage should be taken into account. When recommended minimum spacings are adhered to, a coverage of 30 percent is about the top limit, though this may sometimes be exceeded. This coverage is approached in plans for three-story apartments at a net density of about 50; for two-story row houses (with some flats at the ends) at a net density of about 30; and for one-story row houses at a net density of about 15.

For projects with a density higher than 50 it is suggested that the coverage decrease slightly as the density goes up. For densities below 50 the coverage should preferably be less than 30 and should decrease rather rapidly. A reasonable control of density and coverage may be maintained by the use of a variety of building types of different story heights. It is well to remember, however, that a project may have low coverage and still suffer from lack of usable open space if buildings are poorly related in plan.

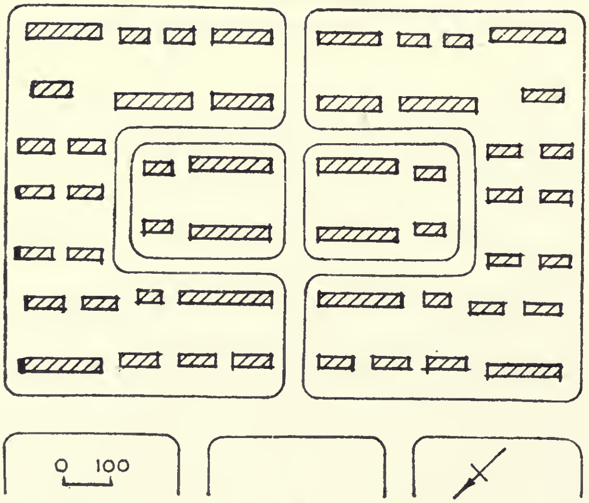
Variations in net density result from differences in dwelling plan types and the number of stories. The normal high limits of densities for various dwelling types, when planned according to recommended minimum spacing standards and with an average of two bedrooms to a unit, are set forth below, together with typical plans, some suggested and some actual, illustrating how density and coverage are affected by plan types:

1. Single one-story or two-story houses may be planned at a density of usually not more than eight units to the acre. Single houses occur in public housing developments only occasionally, however, and usually only in combination with other dwelling types.
2. Twin houses, usually one-story, may be planned at densities up to fourteen units to the net acre.



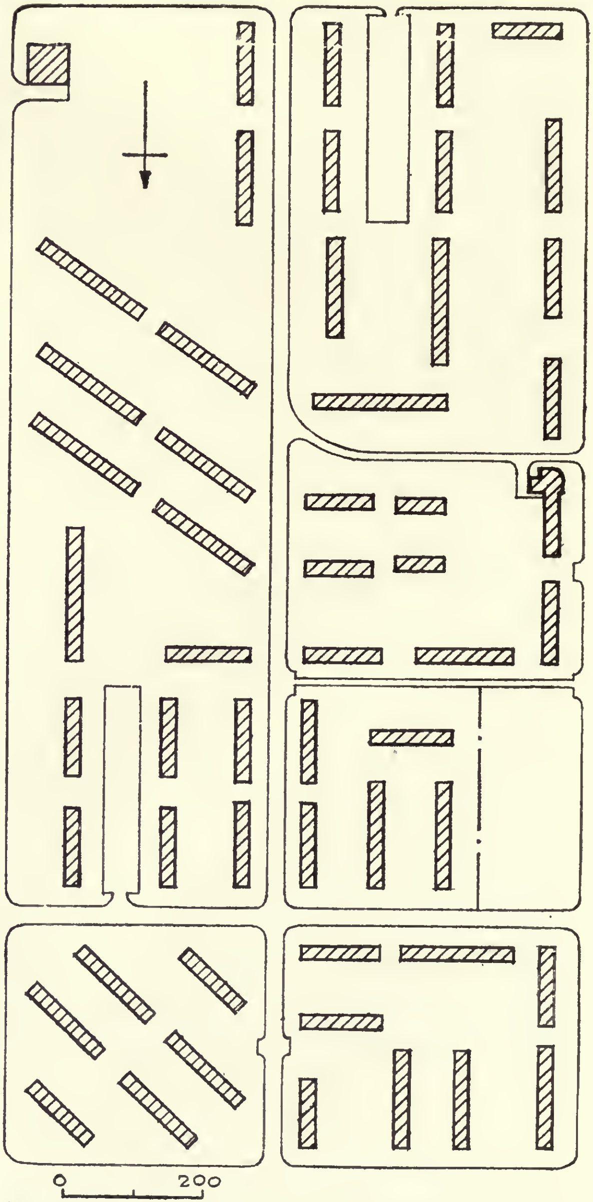
One-story twin houses result in a plan of low density

3. One-story row houses usually produce densities of fifteen units to the net acre. When so planned this type provides about 80 percent to 85 percent as much yard space as the twin house at the maximum density of fourteen mentioned above. With efficient sound reduction between interior units and with adequate space between buildings, these row house units afford a high degree of privacy.



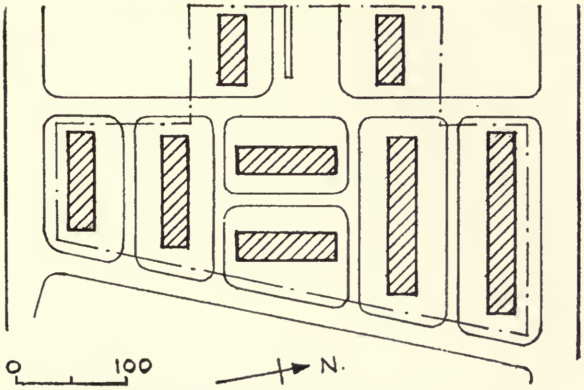
The addition of one-story row houses increases density with little loss of yard space

4. Two-story row houses may be planned at a density of twenty-four units to the net acre. This figure may be increased to twenty-eight or thirty if about one-third of the total number of units are built as flats at the ends of the rows.



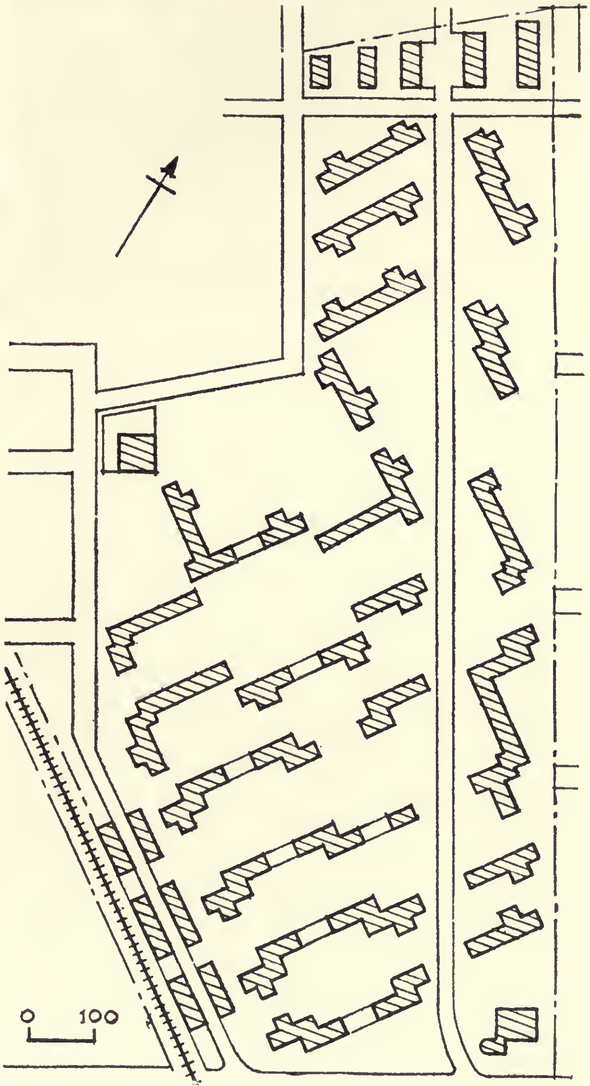
Two-story row houses produce still higher, but moderate density

5. Two-story flat buildings may be planned at a density of thirty-six to the net acre. The construction cost of flats is somewhat less than that of row houses. Buildings composed only of flats, however, are found less frequently than are row houses, or row houses with flats at the ends; this last arrangement makes it possible to assign private yards to second floor tenants, and heating arrangements are simpler when coal or oil is to be the fuel.



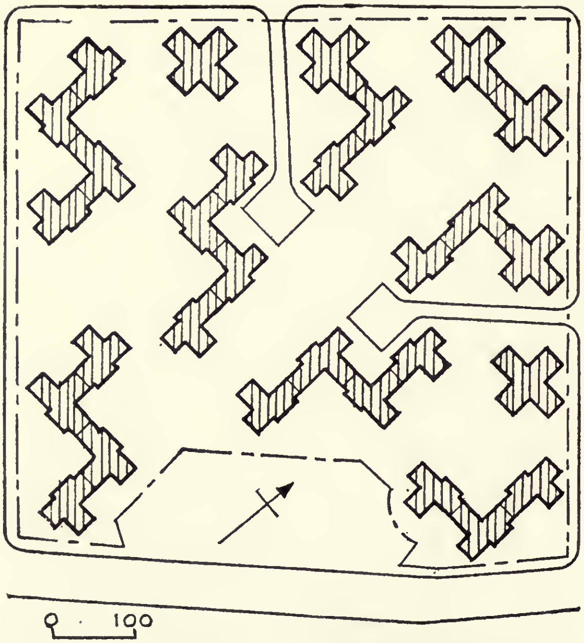
Two-story flat buildings have relatively high density

6. Three-story apartment dwellings may be planned at a density of fifty units to the net acre. This figure may be a trifle high, because of factors in the site plan, but it is offered as a reasonable maximum for trial. In a few cases the density of fifty has been exceeded.



Three-story apartments may reach a density of fifty families an acre

7. Apartment houses of more than three stories may be planned at densities varying from fifty to one hundred, depending upon story height and local building restrictions; but higher densities are difficult to justify.



Where necessary, high apartments for densities up to one hundred units an acre can be planned without excessive ground coverage

CONFORMANCE OF DWELLING TYPES TO NEIGHBORHOOD PATTERN

In the following discussion a clear distinction is drawn between the plan of dwelling types as distinguished from their appearance as buildings, in other words, their visual architectural quality. In considering whether or not a public housing project is incongruous with its surroundings, the matter of appearance is, of course, highly important, but this chapter is concerned only with the suitability of plan types for particular locations, that is, whether row houses, flats, apartments, a combination of these, or other types are best fitted for and in harmony with their neighborhood patterns.

The complexity of the whole problem of dwelling type selection becomes more evident when it is considered that the preceding discussion sets up general rules to establish density (and thus, to a large extent, dwelling types) through a relationship with land costs, without direct reference to the fitness of type to neighborhood character. This does not necessarily involve a conflict, since in many cases the patterns of neighborhoods privately developed have themselves been to a large extent guided by land costs. But the possible conflict does point to the fact, stated at the beginning of this chapter, that all of the criteria which should govern dwelling type selection cannot fully be met, but can only be well considered and brought into the best possible balance.

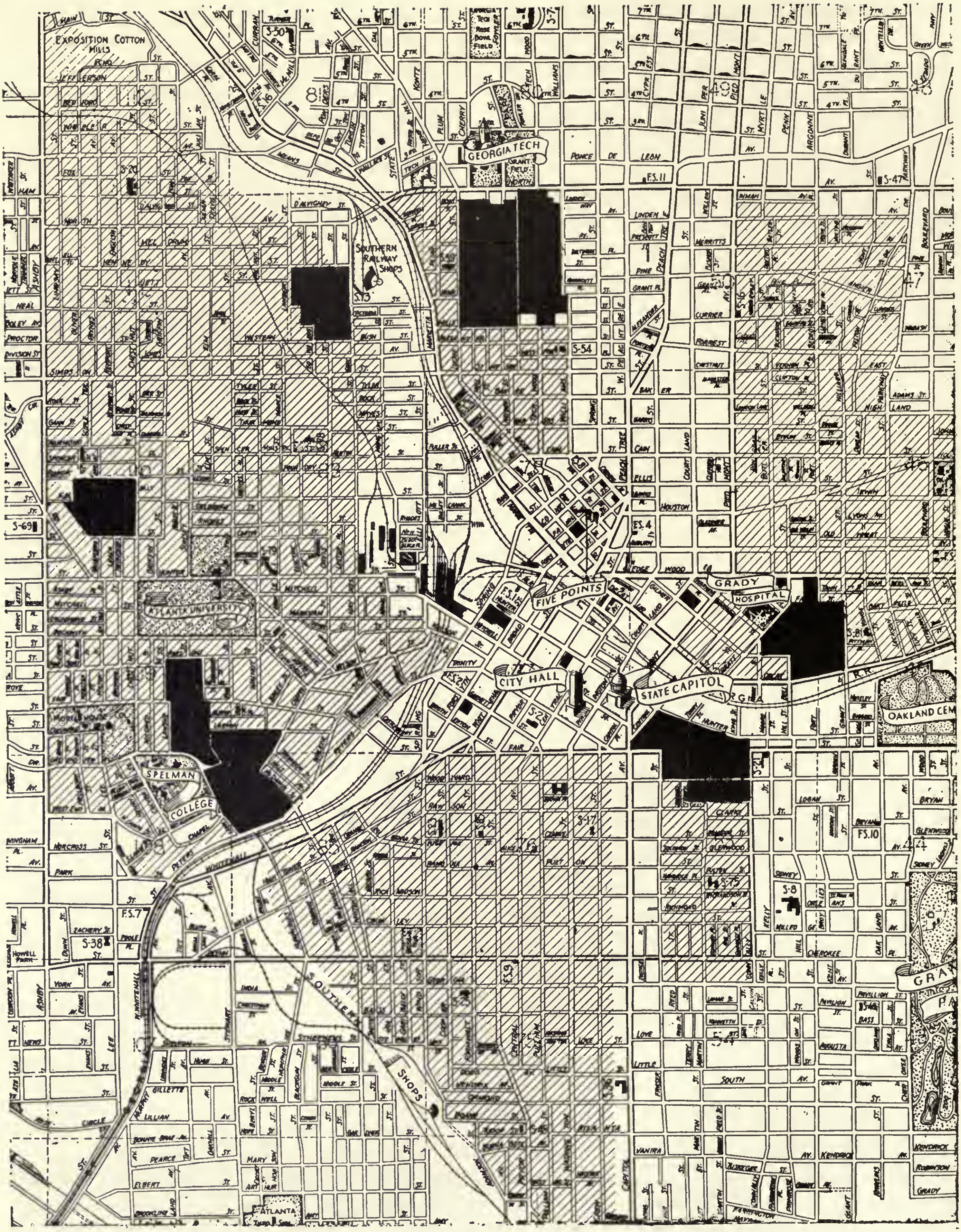
It would be simple to point out a few readily apparent (and more or less absurd) cases of incongruity, such as a dense apartment project set in the midst of a suburban development of detached houses, or the more extreme case of twin houses located in an area densely built up with tall apartment buildings. Such errors, of course, have not been made in public housing, but improper decisions could be reached when questions arise as to whether or not, for instance, three-story apartments would be out of harmony in a section composed largely of two-story row houses, or whether row houses would injure a neighborhood consisting mainly of detached or twin houses located on relatively large lots.

Conditions peculiar to individual communities and deeply rooted in local customs and traditions will often bear upon the decision. In some localities the prevailing dwelling types serve unquestionably as prototypes for new developments. For example, in some cities in the Atlantic Coast region, the predominating type of housing unit, the row house, is not inconsistent with types well adapted to public housing, and the problem of conforming to present neighborhood character with respect to dwelling types is not difficult.

On the other hand, many cities contain very large blighted areas where outworn dwelling types tend to persist over a great period of years. Obviously, in many such cases, other types of an entirely different nature must be used.

A large city in Georgia is typical of communities which have extensive areas of old, closely built, detached and twin frame houses within a radius of two or three miles of its core. It would have been unsound to consider this old type of dwelling for new developments. The local authority, therefore,

In some cities the row house is the normal dwelling type



Low-rent housing is distributed rather regularly around the city center

Old closely built frame houses are replaced by two-story row houses

wisely decided to set its own pattern and chose the two-story row type as the general standard, regardless of the surrounding neighborhood.

Since this particular program has been fairly extensive, and since the projects are spotted rather regularly around the heart of the business center, these new row house projects, rather than the bulk of existing housing, may become the "neighborhood pattern" in determining future types, whether private or public.

> Entirely surrounding the projects (made up of row houses) is private property (almost all detached and twin houses) whose opportunity for resale has been vastly improved because of the new neighbors built by the housing authority. The president of the Real Estate Board says, "It is evident in such sales as have already been made that property adjacent to new housing has enhanced materially in value". — Georgia

The housing authority is chiefly concerned with establishing harmony with the anticipated growth and development of neighborhood character. While trends are sometimes unmistakable in what they predict, the best medium for appraising the future is studies completed or in process of development by local planning bodies. These studies will fix main and subsidiary traffic arteries, both for rail and road; will locate parks and other recreational adjuncts to community life; will determine logical and suitable situations for primary business, for schools, for commercial and industrial areas; and most important of all, they will locate residential neighborhood units in proper relation to the other sections. It is inevitable that these residential neighborhoods will differ, and it becomes highly important that these differences be considered in their effect upon the choice of dwelling types.

Recognition should be given not only to the trends in neighborhood character which may be indicated by long range plans, but also to the effect which such plans may have upon the physical forms of projects, such as street patterns and grades. To identify and evaluate these influencing factors and reflect them in project design—starting with selection of a type most fitted to a future not too clearly defined at best—will impose upon housing authorities and their planners responsibilities and limitations that may be highly irksome. They may feel that the problems are already sufficiently difficult without the introduction of special factors and of the necessity to consider things not immediately related to the problem. But the proper integration of public housing with the community as a whole, not only for the moment but for the future as well, is a challenge to the ability, the imagination, and the resourcefulness of the local authority which such a body cannot afford to overlook or to discount.

> Row houses are considered undesirable for the reason that they are at too great variance with the pattern of the community: It is desired to construct twin houses and some two-story, four family structures. — Illinois

> The row house type of project is best suited to this locality. — Connecticut

> Study of nearby projects and local living habits, etc., indicates that these projects should be of small groups,

that is, twin or at most four dwelling units per group. — New Jersey

The one-story twin house is considered to be a very acceptable building type for low-income families. — Montana

A housing project should be a logical and natural part of its surroundings and should not be isolated by reason of its own peculiar characteristics. Hence, it should consist of housing types either in harmony with a desirably static neighborhood, or compatible with the indicated future character of the neighborhood. Conformance to neighborhood pattern should not be a blind rule to sanction the continuance of mistakes.

Dwelling types, not extravagant, but better than those which may happen to prevail in a blighted neighborhood may justifiably be chosen. But it would not be sound—or fair—to build types that would tend to depreciate neighborhood values. However, one of the noteworthy effects of public housing up to the present time has been its consistent tendency to appreciate values. Finally, it should not be overlooked that the site plan design, especially the street layout and the placement of the buildings, will determine to some extent a project's integration with the neighborhood, and that preliminary site planning considerations are closely bound in with the selection of dwelling types.

SELECTION OF TYPE AS RELATED TO RENTS

To provide dwelling types that will be suited to the general economic level of the tenants for whom a project is being developed simply means to supply housing which may be rented at rates, adjusted to tenant incomes. The proper relationship of income to shelter rent is accepted as being not more than one-fifth of the total family income for families up to five persons, or more than one-sixth of the total income for larger families. To establish rents at these levels for families of very low income, without recourse to excessive subsidy, means to provide housing not only low in capital cost but also economical to operate.

No particular type of housing automatically produces its own particular basic rent schedule. Under some conditions projects composed of twins may be rented at lower rates than dense apartment-type projects, but the reverse condition may also be true. The result is dependent upon many factors which resolve themselves into two main heads: capital cost and operating cost.

Capital cost consists principally of three major items: the cost of land, the cost of improving and fitting this land for use (site improvement work), and the cost of the buildings. Of these three items the cost of land per dwelling unit is probably the one which can most readily be kept within control by the selection of a site and by the density applied to it. The cost of the buildings is probably somewhat less easily controlled, since there has been, and doubtless will continue to be, a range between the cost of various dwelling types. That difference has ranged from one to fifteen percent, disregarding occasional extremes of both high- and low-cost units. The third item, that of the cost of site improvements, has been found to cover a wide range, frequently without much apparent reason; hence this cost can be said to be the most difficult of all to keep within control.

The cost of operating a project breaks down into a great many items. Many of them are closely related to the types of dwelling used, their design and construction, how the site as a whole is planned and built, the fuels and the utilities selected, the community facilities provided, and the extent to which tenant maintenance is implicit in the design or is required under the terms of tenant leases.

In other words, rents, which must be within economic reach of the tenants, are affected by the following factors, all of which are related to the type of dwelling selected:

1. The site density. This is largely dependent upon the dwelling type and determines the cost of land per dwelling unit.
2. The cost of actual construction. This is somewhat affected by the dwelling type. For example, one-story twin houses may cost up to fifteen percent less than apartment units, which must be of heavier construction.
3. The cost of site improvements. This is a very heavy cost item (frequently much too heavy) and is very definitely affected by the type of dwelling.
4. The cost of maintenance and operation. This is closely related to the type of dwelling as well as to its construction, its materials, and its details: for example, the plan type which involves a high degree of tenant maintenance (chiefly in outdoor

Low-rent dwellings can be a natural part of their surroundings (above) and not isolated by their particular characteristics (below)

areas, but in public spaces within buildings as well) will result in lower operating costs.

Most of these points are discussed in some detail in appropriate sections of this review. Here it is only repeated that since the prime purpose of public housing is to obtain satisfactory low-rent dwellings for low-income families and since the dwelling types chosen may affect this purpose either favorably or unfavorably, the selection must be based on thorough consideration and analysis.

> Our experience would indicate the wisdom of semi-detached or group houses where possible. Land cost will determine where apartments will be required. — Connecticut

> While the final decision has not yet been reached on the types of structures, we are expecting to make a fuller use of semi-detached houses, with group houses where necessary to tie in with existing work. Some will necessarily be of the apartment type, where site cost requires it. — Ohio

TENANT CHARACTERISTICS AND NEEDS

The matter of adjusting the selection of dwelling types to the special characteristics and needs of the tenants is quite a different thing from adjusting it to the tenants' economic status. Furthermore, the problems of special characteristics and needs, while closely related at some points, must be defined and be considered separately.

The special characteristics of tenants derive from their national origins and from their environmental and occupational status. There are things desired by some groups that are of less importance to others. Hence it is in the very nature of things that some local authorities will be faced with questions arising from such differences, which can, in any case, be answered within the framework of the "Minimum Physical Standards".

Not all projects can be planned, naturally, with complete foreknowledge of the group or groups to be housed. Many projects have been occupied by tenants representing a large proportion of all racial and occupational groups; and experience has shown that such groups tend in time to coalesce. This may be because the youth of project families has a way of shaking off the traditions and customs of its parent generation, and also because general community influences operate more quickly upon a consolidated neighborhood than upon scattered individuals.

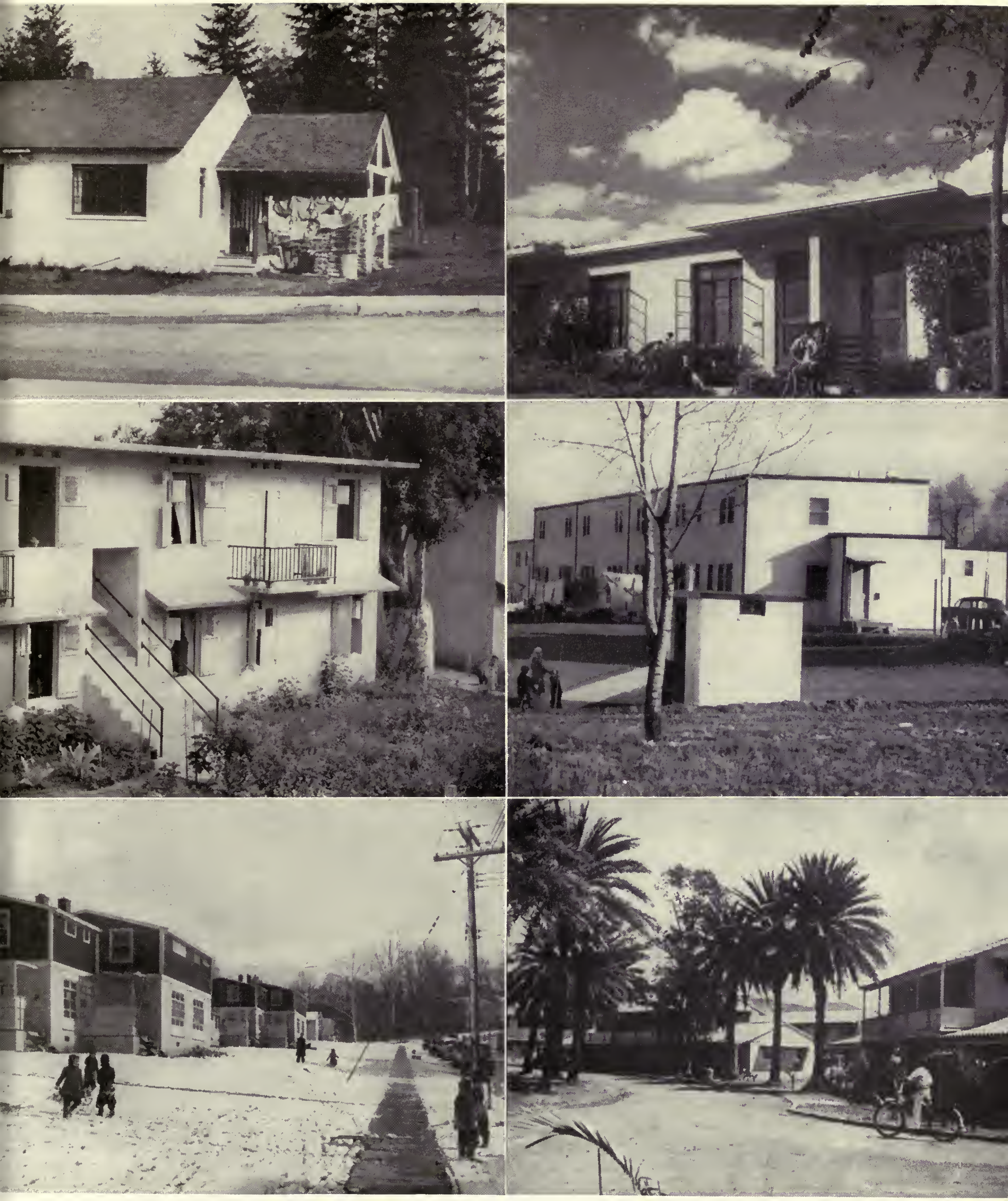
In a very large number of cases, however, projects will be developed for specialized occupancy, and the particular characteristics of the proposed tenants cannot be ignored in selecting dwelling types. Just where the differences lie and to what extent they call for variations in types of accommodations is not a subject appropriate to this review. Each community must study and know its local problems and must meet them as it sees best in each case.

This has been done in the past successfully by many local authorities: witness the manner in which public housing has served varied groups, different in national origin, and all possessed, to some degree, of different characteristics stemming from their origins, from natives of the West Indies to descendants of early settlers in Pennsylvania.

The accompanying illustrations of projects designed for these different groups will not reveal startling variants from housing developed where there is no marked evidence of racial differences; and this is as it should be. But frequently there are things in each of them that grow out of the customs and habits and even the special desires of the groups housed; this, also, is a desirable condition.

The needs of tenants, as the term is used here, are those which derive from family size and composition. Public housing technicians must weigh these needs carefully and must design projects to accommodate an established ratio of family sizes and various types of family composition. Briefly, consideration of a project starts with a market analysis. This analysis, as explained more fully in other FPHA documents, establishes the number of families living in substandard housing; the income range of all such families; and the income range, the ratio of family sizes and the composition of families by age and sex for that segment of the over-all group which the local authority determines should be housed in the specific project under consideration. Thus an element not common to the normal process of providing housing is part of the planning of public housing. This affects first, the selection of dwelling types most appropriate to the anticipated tenant needs, and second, the adjustment of room ratios and room sizes in planning the dwelling units themselves.

The following paragraphs deal with the general nature of the problem as related to the types of dwellings to be selected. The effect of the problem



Dwelling types affected by climate and custom upon the number and size of bedrooms and upon the size of living rooms, dining rooms, and kitchens is discussed in "The Dwelling Plan".

Families with children prefer types which permit easy access to a yard; this is important, particularly if the children are young. For other families access to grade without stair climbing is not necessary except for the operation of individual coal-fired heating plants.

Some surveys indicate that older couples and young couples with babies are more comfortable in quarters where the constant noise and confusion normal to child play is not too near. Experience shows that the greatest strains occur from communal stairhalls and from impact noises in ceilings. Some managers ask for one-bedroom "buffer states" between groups of dwellings for large families, so that too many variously aged children are not thrown together.

> Multi-story buildings containing dwelling units housing a number of children are, we find, extremely unsatisfactory. It is our opinion, in this area at least, that no buildings should be over two stories in height.
> — Ohio

> Dwelling units should be so distributed in the various buildings that no section of the project is left with no small units or with nothing but small units. — Georgia

An examination of 503 USHA and FPHA projects built before April, 1942, shows a preponderance of the row house type. Also an analysis of the distribution of large and small dwelling units in projects consisting of combinations of row houses and flats or of row houses and apartments shows that the larger units (those with two or more bedrooms) were planned, in so far as was practicable, in the row houses. In this way the majority of the units tenanted by families with children are close to the ground.

A project in Connecticut illustrates this desirable relation: 80 percent of the total units, the larger units, are planned in row houses (some with end flats) and the remaining 20 percent, the smaller units, are planned in apartments. There is an added advantage of savings in total development costs derived from a more economical arrangement of the smaller units in apartments than is possible in row houses.

Families with children want to be close to the ground

Steep grades call for careful planning but provide light, air circulation and pleasing views

RELATION OF TYPES TO PHYSICAL NATURE OF SITE

Most of the points mentioned here seem self-evident, yet errors have resulted from neglect of their proper consideration. Assuming that a project site has been chosen in light of all the factors discussed in "Site Selection", nevertheless it may, because of combinations of circumstances, have certain undesirable characteristics; among these might be found the following, singly or in combination: unusual irregularities of project boundaries; difficult surface grades, for example, grades very steep, very flat, or very irregular; difficult subsurface conditions, for example, conditions unstable, stable but water-bearing, or involving areas of underlying rock.

The question arises as to just how the nature of the site conditions should influence dwelling type selection. The following paragraphs, based on actual experience, will illustrate some of the points and their solutions.

Irregular Boundaries. This factor will not, ordinarily, influence the choice of predominant dwelling types in the project. But it may result in the introduction of a type different from that of the development as a whole, in order to use oddly shaped or constricted areas within the project boundaries.

Grade Conditions. The prevalence of grades below one percent, and above five percent, always has a definite bearing upon the planning of the site—that is, the placement of buildings, location of streets and walks, and in the design of the drainage system. Grades steeper than seven or eight percent introduce a special problem in the design of dwelling units, though the particular type selected is usually determined by the density desired and by other controlling factors. If there is an even choice, however, between row and twin houses, on a steep slope, twins might be chosen to reduce grading and to facilitate drainage.

Special designs that have proved satisfactory for steep sites are three-story apartments with garden apartments having one exposure on the low side, and row houses with one-half story below grade on the uphill side. The latter, owing to their wider frontage, have usually proved more costly than standard row houses. They are especially desirable, however, if tenant-operated coal-fired heaters are to be used, since coal storage is facilitated. Twin houses and in some cases, row houses, supported by piers on the downhill side, have proved economical. On sites with very irregular topography there may be a definite advantage in using standard units on the moderately sloping land and special "hillside" units on the steep land.

All types of buildings are suitable for sites that are nearly level. If a low density is desired, however, there should be a careful check of site improvement costs, since good drainage of the site will probably prove to be expensive.

Unstable Subsurface Conditions. The stability of subsurface material also influences the dwelling type. If yielding material is present, special provision in the way of spread foundations, deep footings, piles, or other means for carrying the loads are required. This, in turn, means that the extra cost per unit will be in inverse ratio to the number of stories in the buildings. Thus, as a general rule, the high cost of foundations brought about by unstable subsurface conditions can be absorbed more readily by multi-story buildings than by low buildings. Under conditions where the subsurface conditions are not very abnormal, of course, the extra foundation work for low buildings will be proportionately less expensive.

Water-bearing Subsoil. If water is present in a soil, but it is otherwise well suited to carrying the building loads without special foundations, the problem, in so far as it affects dwelling type selection, is merely one of waterproofing or designing to minimize the need for waterproofing. The choice of low buildings without basements is the simplest solution. Taller buildings, on the other hand, can offset the increased cost of waterproofed basements because of the additional number of units provided.

Underlying Rock. If a site has rock formation within a few feet of the finished grades, dwellings without basements are certain to be the most economical. Careful exploration of subsurface conditions should be made before site selection, and only under the most exceptional circumstances should sites underlaid with rock be chosen. Where land costs are high, so that multi-storied buildings are required in any case, this problem resolves itself automatically.

RELATION OF UTILITY AND HEATING SYSTEMS TO DWELLING TYPE

It is more logical, as a general rule, to adapt the utility services and the heating to the type of dwelling best suited to the over-all needs than to select a combination of utilities and a heating system and then to choose a dwelling type which suits them. Yet in some cases advance knowledge as to the probable utilities, system of heating, and more particularly the fuels to be used, may be the deciding factor in dwelling type selection when two or more types are otherwise equally useful. If individual gas-fired heaters are to be used, for example, some dwelling units may be placed in separate flat buildings or in flats at the end of row houses. If tenant-operated coal- or oil-fired heaters are to be used, two-story buildings composed entirely of flats are not satisfactory.

On an outlying site to which utilities must be extended over a considerable distance it may prove impracticable to plan a project of twin houses or other low-density types because of the high cost per unit for site improvements.

RELATION OF TYPES TO BUILDING AND ZONING REGULATIONS

While building and zoning regulations may not always be mandatory in the case of public housing projects, it is sound policy to follow such regulations or to secure waivers.

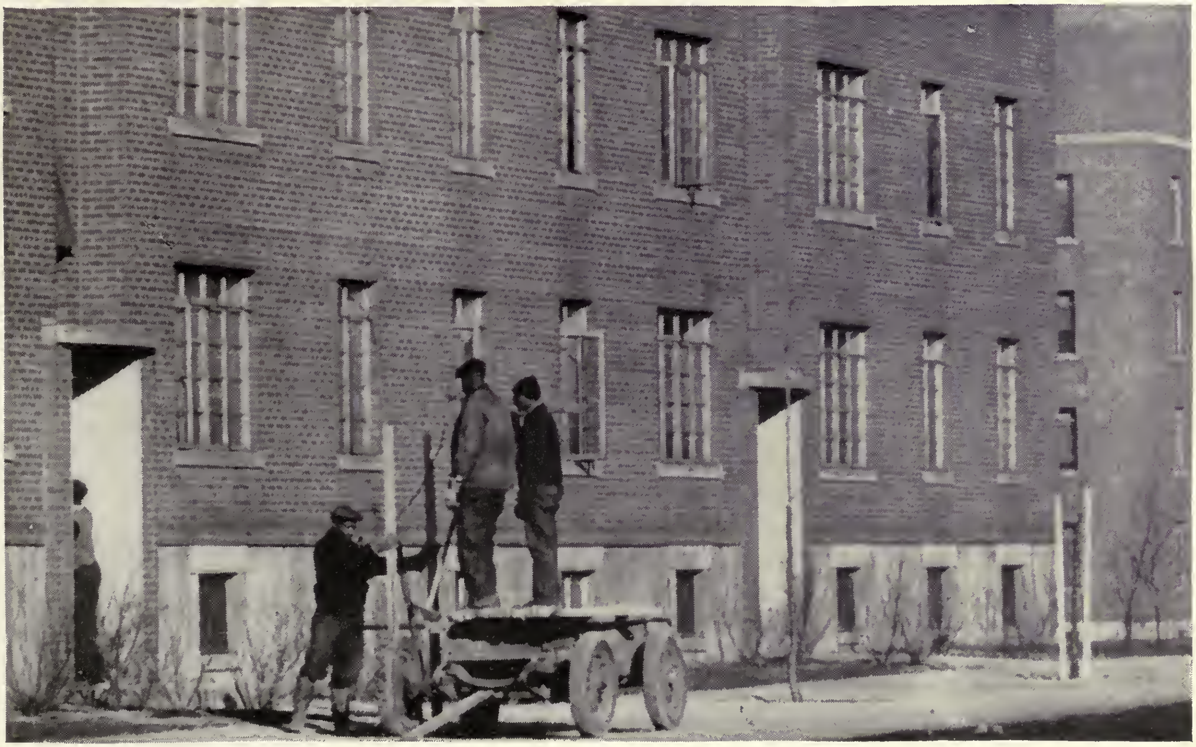
Most building and zoning regulations are quite specific in their limitations on dwelling types, number of stories permitted, and maximum ground coverage. Nearly all existing regulations affecting these matters, however, do not take into consideration projects of the scale of large public housing developments which create in themselves, if not entire neighborhoods, at least the controlling influence for neighborhood development. For this reason housing authorities have seldom encountered serious opposition to the securing of waivers. There are even instances in which rezoning or the granting of waivers for public housing projects has been followed by general rezoning in the neighborhood of the projects.

The Dwelling Plan

THE underlying considerations governing the selection of the dwelling types, that is, whether they shall be row houses, flats, apartments, or others, have been discussed in the preceding chapter, but it should be borne in mind that the reasoning behind the selection of any one type must, to a large extent, carry into the dwelling unit plan itself. Space arrangements, facilities afforded, relationship between indoors and outdoors, and many other factors bearing upon tenant life and activity will all be affected by the considerations which influenced the choice of one type as against others. The following generalizations are noted to underline this point.

Apartments require central heating, with janitorial and other services; they result in high-density projects. This indicates a minimum of tenant responsibility with respect to both buildings and grounds: group recreation and other activities will predominate over individual activities. The unit plans should reflect these and other conditions inherent in apartment projects, particularly with regard to necessities such as planning of common halls, stairs and exits for safety and convenience; provision of special facilities for waste disposal; utilization of basement spaces for tenants' storage rooms and central laundries; provision of some added spaces or other advantages in recognition of the lack of porches or readily accessible outdoor sitting areas; and special regard for sunlight, free circulation of air and pleasant views.

Apartments require some janitorial and other services



Most low-rent dwellings are planned for tenant care

Twin houses call for tenant-operated heating systems and require the fewest managerial services; their low density permits large yards and other outdoor areas. Such projects permit more tenant use and care of outdoor spaces and a more individual attitude toward the project as a whole. Group recreation and other activities are less significant than they are in apartment projects. The unit plans reveal pointed differences in tenant needs and their modes of living. Within the dwelling the heating system and its fuel will exercise much control over the plan; storage space will be larger than is normal for apartments; provision for all laundry work will be included; the system of waste collection will be recognized. Gardening will require some storage space for tools; laundering will be related to drying facilities outdoors; and the inclusion and location of porches merits special consideration.

Flats may be either centrally or individually heated and are of lower density than apartments. Some part of grounds maintenance can be assigned to the tenants but, on the whole, tenant interest and activity will resemble that of apartment dwellers. Logical differences in plan essentials will, however, be apparent.

Row house projects, although of higher densities than those of twin houses, will tend to operate in the same way as the latter, so far as tenant responsibility and interest are concerned. The basic differences in unit plan will only be those enforced by the restriction of door and window openings to front and rear walls.

All this points to the importance of proper integration of the unit plan—as dictated by its dwelling type—with the site plan, for it is through such integration that unity between individual dwellings and the project as a whole is achieved and the tenants are given the widest opportunity for pleasant and useful enjoyment of the development.

This welding of the unit plan with the plan of the site will require skillful handling of both practical and esthetic problems. Thus, among many items, smoothly working relationships must be established between the dwelling plans and the spaces and services provided in the site layout for disposal of waste, for laundry work, for handling of fuels, and for the delivery of goods. Ready and safe access to outdoor areas, especially for small children and elderly persons, is necessary; and, if at all possible, a vantage point from which mothers may observe their children at play is desirable.

Windows, beyond the primary consideration of affording abundance of light and air, should be strategically placed with relation to the site plan to stimulate interest in outdoor activities, to provide attractive views, and to produce a feeling of spaciousness—an attribute difficult to attain within the dwellings themselves.

> Windows: Large ones in kitchen are excellent for light and keeping track of small children outdoors. — Connecticut

These and similar points may seem so obvious as not to warrant reference, or so trivial as to be of little consequence to low-rent housing. Nevertheless, that they are worthy of deep consideration is proved by the contrast between projects which satisfy them, even if only to a reasonable degree, and those which evidence disregard or lack of interest in such details.

GENERAL CONSIDERATIONS

It is elementary to say that the purpose of a house is to shelter its occupants and to provide them with space and facilities wherewith they can conduct their normal activities conveniently and with satisfaction. But there is some evidence either of an inadequate knowledge of these normal activities and of the multitude of details that accompany them or else of their disregard in favor of doubtful economy. The difficulty probably lies in the fact that any program of low-rent public housing must have a base of minimum standards, and that increases in these standards must be justifiable.

It seems worth while to consider, briefly, the requirements upon which the physical standards of development are based: They provide for the construction of decent, safe and sanitary housing, not elaborate in design or more costly than that currently developed by private enterprise, and within the financial reach of families of low income.

Mothers like to watch their young children at play

Undoubtedly there has been much struggle on the part of project designers to reach a nice balance between bare need (decency, safety, sanitation) and whatever degree of amenity seemed justified. It must be noted that while bare need has usually been served, in many cases the margin has been narrow. And both need and amenity have sometimes been subordinated to a misdirected creative urge: straightforward expressions of properly solved plans and of simple systems of construction have produced the most satisfactory results.

Minimum standards require the provision of spaces for general living, preparation of food, eating, and sleeping and for the storage of household possessions and supplies. They also require facilities and equipment for heating, lighting, cooking, food preservation, laundering, and sanitation. The problems related to facilities and equipment are technical in nature and relatively easy of solution; the greater difficulty lies in the matter of space and its arrangement.

It does not satisfy the problem merely to include rooms, closets, and storage spaces of minimum standard sizes; these may be but poorly suited to their purpose if they are not well related as to position, or if they do not take into consideration the furnishings and things that will occupy them and the people who will use them. Here is where intimate and sympathetic understanding of the families to be housed is vital to the success of the project, where actual need must be recognized and where the value of true and justifiable amenity must be appreciated.

Since experience in low-rent public housing is somewhat limited and since instinctive judgment in any new planning field is fallible, how may the designer reach answers at least reasonably satisfactory? The answer must, in the end, lie with the designer himself, but it is the intent of this chapter to aid the designer through comments based upon the record of actual experience. It should be noted that this record is compiled from many sources: observations resulting from field trips by FPHA staff officials; local housing authority conferences; evaluation studies by disinterested architects; the record of day-by-day experiences in management problems; group management conference reports; and studies in the various specialized fields of housing design and management.

From one of the sources referred to, "The Livability Problems of 1,000 Families", some random quotations are pertinent to the subject of dwelling

The kitchen is preferred for dining, even where it is open to the living room

unit planning; they reveal the scope and seriousness of the problem:

> 80 percent of families have children. More than 50 percent of these have children less than four years old. This indicates the consideration to be given to enclosed back yards or other desirable play spaces and to home facilities for laundry.
>
> 50 percent of families have children of school age for whom inside and outside recreation facilities should be provided, and also provision for home study should be made.
>
> Majority of families want more area in the kitchen: 89 percent of families use kitchen for dining; 25 percent for entertaining; 32 percent for children's study; 52 percent for children's recreation; 32 percent for clothing drying; 82 percent for ironing; and 27 percent for sewing.
>
> 435 families out of 1000 owned sewing machines—only 70 families store machines in kitchens—others are stored in bedroom closets.
>
> 50 percent of families wash laundry oftener than once a week.
>
> Majority of families use living room daily, but many living rooms do not have maximum use as they contain families' choicest possessions.
>
> 3 percent of families use living room for dining daily. 5 percent use it occasionally.
>
> Kitchen preferred for dining as tenants are accustomed to this arrangement.
>
> Living room is used by 80 percent of families for children's recreation.
>
> 38 percent of families with school-age children use living room for study.
>
> Need for more wall space in living room constantly stressed.
>
> Wing partitions between living room and kitchen not liked by great majority. — Livability Problems of 1000 Families[1]

The foregoing quotations indicate a lack of understanding or appreciation of needs which might seem to be self-evident. The planner should certainly have at least some reasonable evidence and knowledge with respect to the following items:

1. The kind, number, size and placement of normal furnishings: chairs, tables, beds, divans, and so on, and of such other items as radios, books, reading lamps.
2. Data on items frequently used but intermittently stored: clothing, bedding and linen used currently, children's toys and gear.
3. Data on items used only occasionally or seasonally, requiring storage for long periods: winter clothing and bedding, sleds, fishing tackle, and the like, and many other things used infrequently but not to be thrown away.
4. Information as to household utensils for cleaning: mops, brushes, pails, brooms, vacuum cleaners, dust cloths and rags; washing machines (or tubs and washboards), ironing boards and irons, lines or racks for drying; and (sometimes) spades, rakes, hoes and whatnot for gardening.
5. Cooking utensils, and the array of china, glass and tableware that accumulates and is needed by every family. (Even a casual inventory produces surprising results).
6. Currently used supplies of all sorts: foods, perishable and otherwise, soaps and other cleaning

Bulky household utensils need storage

Work and storage space are needed for pots, pans and tableware

---

[1] National Housing Agency, Federal Public Housing Authority. 1945

materials, toilet and medical supplies, and oddments of various nature.

Storage: Broom closets, wrap closets, in hall and near the back door, cool storage closets, kitchen closets near the stove and near the work surfaces, linen closets, toy closets are demanded almost vociferously. — Technical Division Report

Lack of suitable, convenient and adequate space for all of the many things noted above is one of the distinguishing features of slum dwellings; it is certainly short sighted—or worse—to fail to provide for these needs. And while these and the other considerations in dwelling unit planning that have been mentioned seem obvious, many of them have not always received their full share of attention in the past. Their importance cannot be overemphasized.

CONSIDERATION OF DETAILS

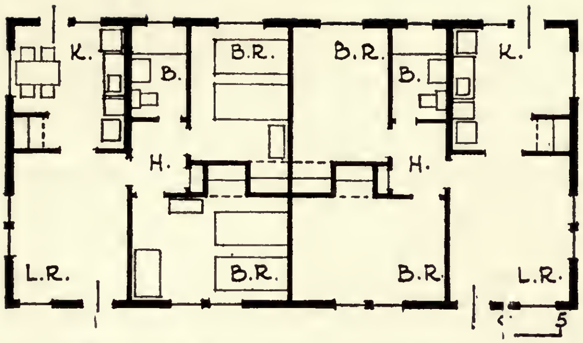
The details following are suggestions derived from experience; like so many things mentioned throughout the review they are generally well known and understood, but are not always considered in the light of their special application to low-rent housing.

A valid relationship between the plan and the structural system, together with its materials, has always been considered as one factor in good architectural design. This principle is particularly important in low-rent housing; the system must be simple for economy's sake, and cost will not permit its concealment by elaborate furring or special tricks in planning. Nor can the structural materials be considered merely as a base for the application of surface finishes; so far as possible they should serve as the finish. Although all architects agree about the soundness of these principles, they have in this kind of work a particularly strong motive for meeting a very ancient challenge. The point is mentioned here because advance consideration of it will influence planning to a marked extent.

High initial costs can be built into the plan just as they can result from unwise selection of structural design and choice of materials. Some typical points that merit especial consideration from the standpoint of economical planning are these: planning for back-to-back plumbing; grouping of chimneys; pairing of entrance doors to permit single walks and protective hoods; avoidance of unnecessary breaks in the plane of walls and partitions, or the introduction of other features merely for architectural effect; minimizing waste space, such as halls, through compact planning; use of stock size windows and other items.

The last point raises the question of modular design and co-ordination of materials. On this score, the FPHA believes that the principle is theoretically sound, and urges architects doing low-rent public housing to keep abreast of developments in this field and to use them to whatever extent they are of advantage in lowering costs.

Paired entrance doors save walk paving



Twin houses have yard spaces on three sides

UNIT PLANNING FOR VARIOUS DWELLING TYPES

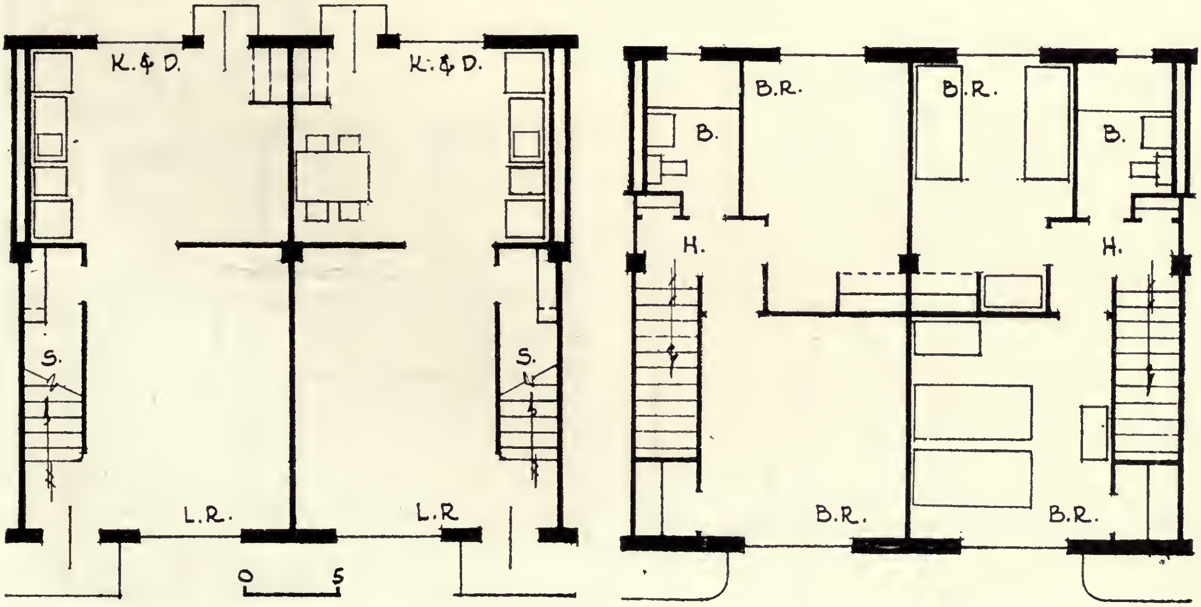
Each different dwelling type suggests its own individual plan characteristics. Architects are familiar with these basic differences. In any event, creative planning should not be hampered by detailed comments leading the designer to predetermined arrangements. Thus, the following comments touch only the highlights of planning considerations for each type, and the accompanying plans are included only to illustrate the general principles noted.

Twin Houses. Advantages and disadvantages: Liked by most tenants because of light and air on three sides, the feeling of individual possession, the use of relatively large yards. Adaptable to inexpensive construction and materials. Some difficulty in planning for back-to-back plumbing, etc., and in grouping chimneys. Larger than average number of windows complicates furniture placing. Lack of mass makes general interest difficult to achieve, both in individual buildings and in grouping.

Row Houses. Advantages and disadvantages: High degree of privacy and livability; front and rear yards are used and maintained by tenants. Depth necessary for economical construction (25 to 28 feet or more), with resultant narrow frontage, makes planning for light and air through waist of unit difficult. Normal area requirements for second floor (bedrooms and bath) greater than for first floor. (Inside bathrooms, stairs parallel to front of building, and overhanging second story are means sometimes used to meet these difficulties). Combine well with flats at ends of rows. Particularly well adapted to "interlocking" plans (location of some bedrooms above the first floor of neighboring units, in order to secure flexibility of unit sizes).

Flats. Advantages and disadvantages: Moderate degree of privacy and livability; combine some of the advantages of row houses and apartments. Yard space can be assigned to tenant use and care. Economy limits their use, normally, to two stories, except on steep sloping sites where one story on downhill side can be added. Greatest disadvantage lies in lack of storage space; moreover, there are

Two-story row houses combine privacy with economy

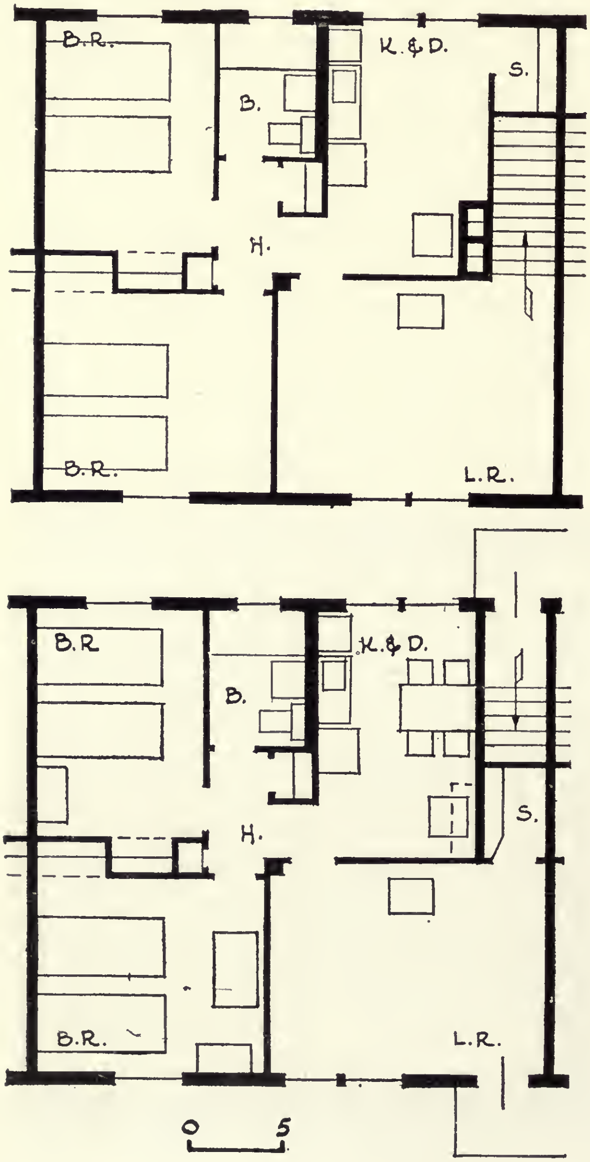


difficulties in heating when used in rows. Economical depth creates a similar problem to that for row houses, even less easy to solve. Storage space for things used outdoors (baby carriages, wheel toys, and so on) and access to laundry drying can be provided, but only through ingenuity. Relation between indoor and outdoor activities worthy of particular study.

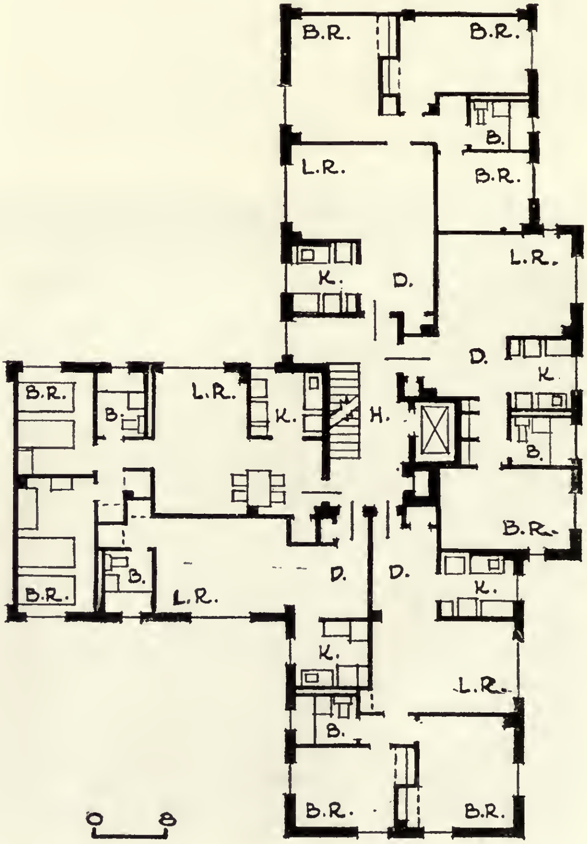
Apartments. Advantages and disadvantages: Greatest convenience to tenants so far as services rendered to them are concerned. Liked particularly by those who are gregarious by nature. The apartment plan undoubtedly calls for more skill and experience than any other housing type. Efficiency in use of space is essential; column spacing restricts planning, so that economy in structural design must be neatly balanced against plan requirements. The relative advantages and disadvantages of the "ribbon" plan must be weighed against the so-called "efficiency" or "cross" types and their variants. The best opportunity for light, air, and free views are characteristic of the ribbon plan; more efficient grouping of stairs, elevators, and other public services are common to the other types. The decision, to a large extent, will be determined by the number of floors, since elevators, which demand grouping, are not required in three-story apartments.

> Great majority of people prefer one- or two-story houses. Very few want apartments in three- or multistory buildings. — Livability Problems of 1000 Families

Flats have rooms and most facilities on one floor

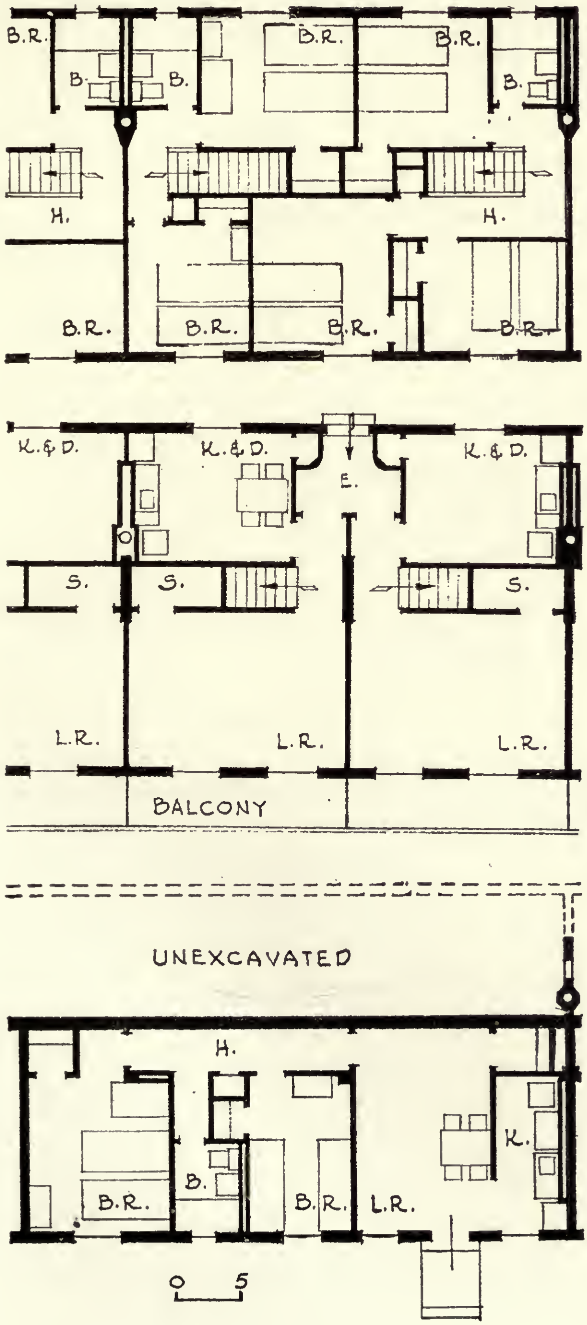


Apartments centralize common services

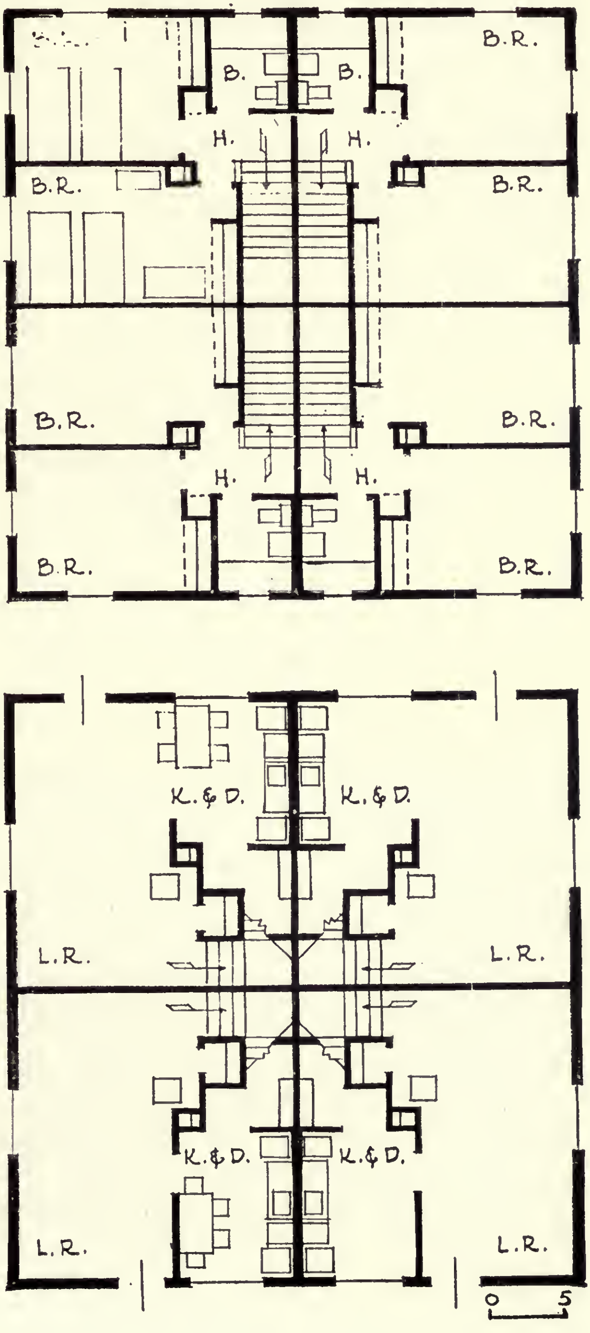


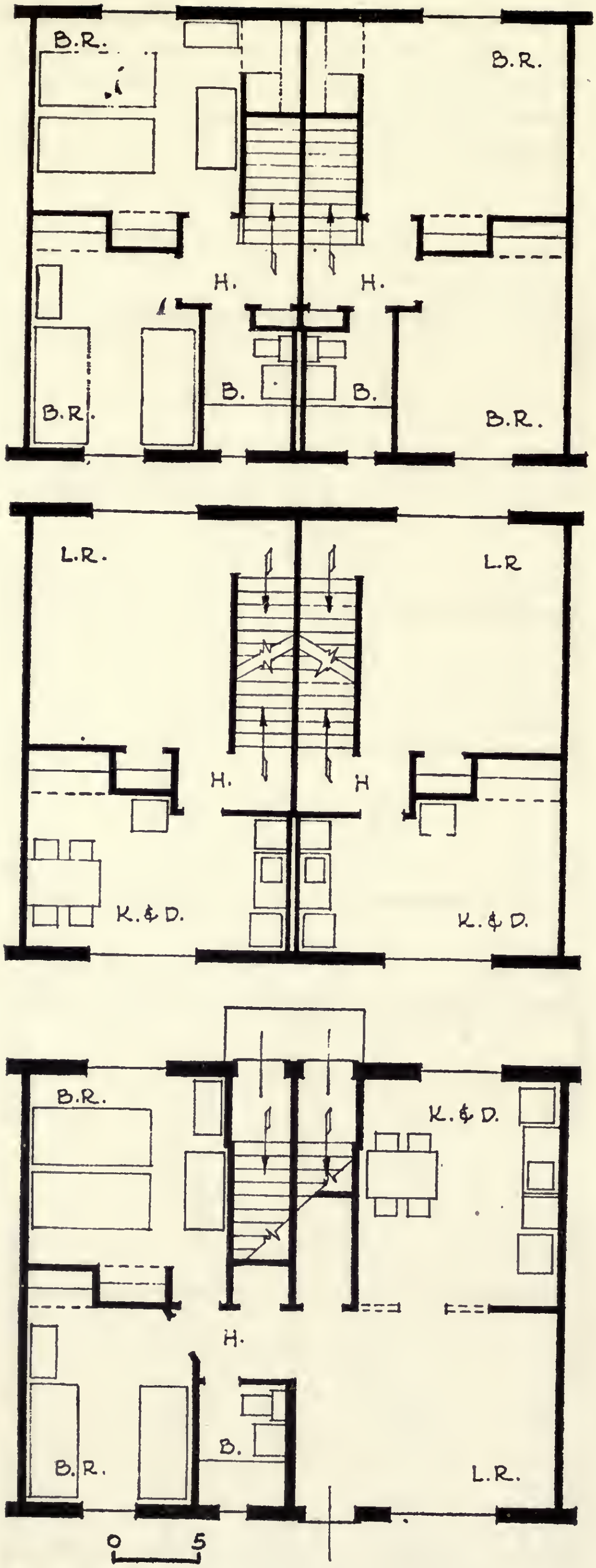
Special Types and Combinations. The accompanying drawings illustrate miscellaneous types that have been used: The hillside or garden apartment type, and the "quadruplex" and "quatrefoil" plans. They also show combinations of flats at ends of row houses, and row houses above flats. All of these are interesting not only in themselves but also in demonstrating that new and useful plan types can be developed, particularly where housing is designed on a large scale for single ownership and centralized operation.

Row dwellings and flats on steep slope

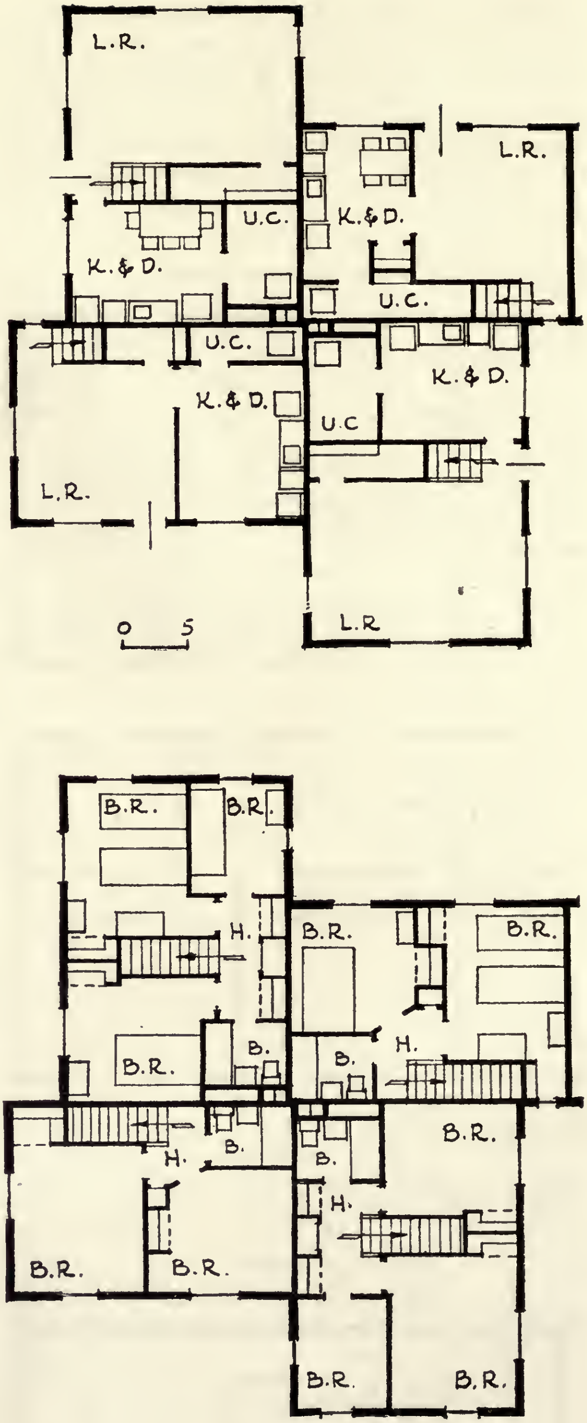


The quadruplex plan, while economical, lacks flexibility in site arrangements

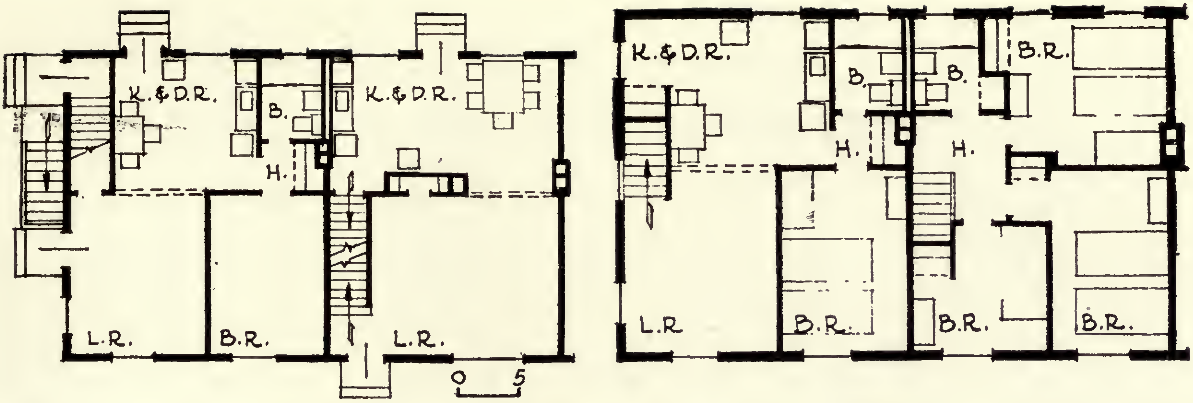




Row houses above flats raise the question of tenant yard allocation



The quatrefoil plan groups utilities and provides through ventilation. It permits greater flexibility for interesting site groupings than the quadruplex illustrated on the preceding page



Flats may be combined successfully with row houses if located at ends of building group

COMPONENT ELEMENTS OF THE DWELLING UNIT PLAN

Living Room. This has sometimes been designed to serve two purposes in addition to general living; when space is added it may be used for dining, and in the past occupancy requirements were occasionally predicated upon its possible use for sleeping. However, experience in many localities shows that most families prefer to have the space for dining added to the kitchen; and there seems to be a definite tendency to overcrowd bedrooms rather than to use the living room for sleeping.

The room affords some use for children's study and play, for ironing, sewing and other household chores, but more often the kitchen is the scene for these activities. The kitchen is often the place for family gathering and for the entertainment of intimate friends. Thus, the living room in public housing has taken over many of the attributes of the old-time parlor. The reason is not too obscure. These tenants, having been accustomed to slum conditions, take more than average pride in their homes; and this pride displays its greatest evidence in the care that is lavished upon the living room. If new rugs or new furniture are to be had, the living room receives first preference; and colorful curtains and drapes are acquired.

Living room—used for children's study and play

Dining space with pleasant outdoor view

Dwelling Arrangement: Living room in front with kitchen in rear is satisfactory for laundry and other services, but necessitates garbage pails and trash cans at front steps. There is no objection to this when proper screening is provided. — New York

Serious objections to need to carry garbage, clothes, and so on from kitchen through living room to each yard. In kitchen it is also necessary to carry coal (not planned for, but gas not available). — Pennsylvania

Tenants almost unanimously preferred a definite separation between kitchen and living room. — New York

Since living room is so frequently furnished with a davenport to accommodate sleeping guests, rooms should be planned so that this will be possible. — West Coast

When you have company, they look right into the kitchen. — Pennsylvania

Put in partition between living room and kitchen. — Washington State

Leave out all partitions between living room and kitchen. — Washington State

Dining Space. Whether it be placed in the kitchen—as most tenants seem to prefer—or in the living room, the dining space still must be adequate in size and convenient in its relation to essential services, and if possible it should command a pleasant outdoor view. When the table and chairs are drawn upon the plan to judge its adaptability, it would be well to remember that these are not all of the small and compact sizes seen in modern shops, and elbow room is needed.

Too often a so-called dining foyer is a poorly lighted, poorly ventilated congested hallway. — Technical Division Report

Universal preference for eating in kitchen. — Eastern Seaboard

Dining in living room would be acceptable if really planned for. This system should be carried out especially where washing is done in kitchen. — West Coast

Kitchen. If the tenants consider that the living room is set apart from workday affairs then they must feel that the kitchen is the shop, the laboratory, town hall, and general headquarters and so, indeed, it is in public housing, for it must serve all of these functions. Cooking, dining, dishwashing, laundry work, care of the baby, play, study, repairing, visiting, supervision, budgeting, and many other ac-

The kitchen—general headquarters for many home activities

tivities, all take place in this small room which must, besides, house countless necessary things.

Start by taking a census of the things one finds in kitchens and in their accessory closets and spaces. Then attempt to fit them into the limited spaces that are provided, and to do this on the basis of enforced economy. Here, truly, is a problem to tax ingenuity. The compactness of equipment and cabinet work and fitments that American industry has produced make satisfactory solutions possible, but only through much thought and hard work based upon full knowledge of what the kitchen must contain and what functions it must serve.

> 19 percent of families found kitchen had inadequate work space. 31 percent found it inadequate regarding storage of perishable food. — Washington State

> More room should be provided around the back of ranges to permit cleaning and to prevent the harboring of vermin and rodents. — North Carolina

Bedrooms. A larger proportion of the bedroom floor area is occupied by furniture than is the case with any other room; windows and doors account for a large percentage of wall and partition space. These two facts taken together complicate the planning of bedrooms, especially when the rooms are small. Convenient arrangement of furniture, an uncluttered appearance, and sufficient free space for movement are not easy to attain.

Inadequate and unsuitable space for storing perishable food

Windows and doors occupy a good part of bedroom wall space

Tidiness is difficult at best and is not promoted by planning that forces a cluttered arrangement. A good working knowledge of the kind, number and size of furnishings the tenants are likely to have is of first importance.

A few suggestions for consideration: Allow free space beyond the limits of door swings; don't destroy good wall spaces by radiator locations; consider location of the closets with respect to furniture; allow space for the crib away from traffic; remember that locating beds too near or facing directly toward windows is objectionable; and place window sills of first floor bedrooms above outdoor eye level if possible.

> Bedrooms: Too small for 9 x 12 rug which tenants have, and use, rolling up extra length. — Pennsylvania

> Bedrooms: O.K. for double bed and lots of furniture. On all projects visited no twin beds seen. (Preference or lack of space?) — Pennsylvania

> The sills of the windows in the apartments on the second floor are too high to see over when one is sitting down, or to afford a cool breeze when one is in bed. — California

Large furniture takes up excessive floor space in bedrooms

Bathroom. Adequate light and ventilation, preferably natural, are first considerations, and ready access to the window without having to bend over the tub is desirable; if, however, layout economy places the tub under the window, this should overrule the advantages of convenience. Placing the water closet adjacent to the tub provides a handy seat for the mother drying small children.

If the lavatory can be located where its user will not be struck by a swinging door, this will be appreciated; and a well lighted space for the lavatory is also welcomed.

A firmly anchored wooden strip placed around the walls is convenient for the attachment of towel bars and other accessories; if hooks and a narrow shelf are added storage space is increased.

Approach to bath through bedroom is bad, eliminates possible use of living room as sleeping room. — New York

Bath: Women like tubs — men like showers. A shower over tub would be a good thing. — Northeastern States

Layout economy generally requires tub to be placed under window

Curtains are an expense to the tenant

Closets and Storage Spaces. Insufficiency of closet and storage space and the absence of closet doors are among the most chronic complaints by tenants. The first objection is too often valid, the second is debatable. The arguments in favor of doors are familiar; dust is a problem, curtains are an expense to the tenant, and a closed door offers concealment. Opposed to this is the question of project cost; incidental arguments are that neatness is promoted by open closets and that the absence of door swings favors furniture placement.

> Most families prefer closets with doors rather than curtains. — Livability Problems of 1000 Families
>
> Lack of closet doors usually objected to, but degree of objection varied with climate and atmosphere conditions. — Pennsylvania

As to adequacy of space there seems no doubt that previous minimum standards were tight; and designers, apparently without question, accepted these minima as being satisfactory. This has been recognized in current standards; it should be noted, however, that the requirements for bedroom and coat closets are not expressed in square feet but in length of clothes pole and width of hanger space. This offers scope for ingenious and compact planning. It is hoped, too, that clever and maximum utilization of odd spaces may produce the required closet and storage areas without undue increase in over-all dimensions.

Although the locations for bedroom, linen, and coat closets are more or less predetermined, this is not true with respect to general storage. The nature of the dwelling type, the manner in which the unit itself is planned and other factors, even the type of fuel used, will have a bearing upon the decision. Thus, to cite a few examples:

1. In apartments the bulk of storage space will, normally, be provided in the basement; only a part need be in the unit itself, and this, obviously, will be located near the kitchen. Since such buildings are heated by project systems, fuel storage is not needed. In addition to general storage the standards require provision of space accessible to grade, for baby carriages—it is a good idea to provide rails to which these may be chained and locked.
2. Flats present the most complex storage problems. When heating plants are tenant-operated—as is normally the case when gas is the cheapest fuel—basements are seldom provided. In such cases all of the necessary storage area is placed within the units, but this necessitates carrying perambulators and bicycles from upper floors to grade.

   Since gas or oil are the only fuels well adapted to individual heating of flats, and since these produce little dirt, heating rooms and general, nonfood storage may be combined, provided free access to the equipment is maintained and fire hazards are avoided.

   When project-operated heating plants are justified, the basement space for boilers and fuel may be extended to provide storage, as in the case of apartments; but since group stairways to basements are not common in flat buildings, access to storage must be from the outside.

   This applies to flats in rows or blocks: if flats are placed at ends of row houses, basements are ordinarily provided for heating, and the storage problems solve themselves automatically.
3. Row and twin house units present the fewest difficulties: they more or less compel the use of in-

dividual heating systems and this, in turn, fixes the storage space within or adjacent to the heater room, depending on the fuel, since in the case of coal the spaces should be separate. It should be noted that these comments are predicated upon the general absence of basements in this type of public housing; further on there are some remarks on this debatable question.

4. In all cases it is preferable to have the storage convenient to both kitchen and exit; spaces for food storage should be as cool and well ventilated as possible.

Cold storage: Should be provided, open to outside air, will help families without mechanical refrigeration. — Regional Report

Linen closets are too small — no storage space to accommodate blankets, etc. Recommend lowest shelf be placed 2′-6″ above floor. — Livability Problems of 1000 Families

The bungalows require more storage space as they have no utility space at all. The all-purpose room combining kitchen, living room and dining areas in these units is attractive, but is crowded, especially where family includes children, because of lack of storage space for children's play equipment. The tenants have no place to store sleds, bicycles, toys, potatoes, etc.

As one tenant remarked: "There is no place at all to put a little hoe, for instance, or a spade." The manager hopes "Washington will find out that all projects should not be alike; New York ways don't apply in Allentown — the Pennsylvania Dutch like a place to store vegetables in." He thinks that cellars should be

Closet design offers scope for ingenious and compact planning

Stair rails need to be designed for safety

provided for all dwellings or none. A general utility room would be a satisfactory substitute. — Pennsylvania

Permanent root storage should receive consideration — additional space needed for this. — North Carolina

Storage: No units have adequate space for baby carriages, bicycles, and so on — they are meant to be kept in apartment basements — that's a long walk, and pilfering goes on. General storage is also in basement. O.K. except that tenants don't like having to go to management for key — and there is dampness. Lack of storage for staple food supplies for large families. Management, to remedy this, installed lockers for canned goods in apartment basements — much used but not ideally located. — New York

Larger utility rooms desired to accommodate double laundry trays and space for electric washing machine. This would eliminate the drudgery and misery caused to mothers on wash day by the necessity of having in the kitchen the washing machine, clothes drying, preparing and eating meals, children constantly underfoot, and many other inconveniences to contend with in a room ordinarily not of sufficient size to accommodate the average family at meal time. — Illinois

Stairs and Stair Halls. A few comments will suffice to cover the less obvious points for consideration in planning stairs and stair halls. The larger-than-average number of children in public housing projects produces heavy traffic up and down: it is particularly important, therefore, to design stairs that are easy to climb and well guarded in the interest of safety. Reasonable relationships between treads and risers; safety nosings for public stairs; absence of winders; rails of proper height (on both sides if the stairs are wide); and, above all, railings on the well side sufficiently closed so that they do not permit either deliberate or unintentional passage. These are all considerations that relate to the use of stairs by children; but most apply to adults as well. Only one other observation seems important: stairs are used for the movement of bulky articles, so that turns must be negotiable and, frequently, the space at the head of row house stairs is so small that large items of furniture cannot be moved through the doors.

MISCELLANEOUS CONSIDERATIONS

All of the items mentioned here—facilities for laundry work, disposal of garbage and other waste, and effect of fuel upon unit planning, have been touched upon to some extent in this and other chapters. It seems appropriate, however, to recapitulate the major factors since these are all vital to unit planning.

Laundry Work. Central laundries are usually provided in apartments, less frequently in blocks of flats, and very occasionally in separate buildings for row houses. In such cases it is not to be expected that heavy laundry work will be done within the dwelling unit. Nevertheless, the possibility must be anticipated and the ownership of washing machines taken for granted.

In projects where no central laundry facilities are furnished it must be assumed that all the family laundry will be done at home. Adequate provisions for this work will include not less than a deep tray in the kitchen, space for operation of a washing machine (and for storing it when not in use), access to an outdoor drying yard or, if that is not possible, sufficient drying space indoors (some space for drying indoors is necessary in any event), and, finally, space for the storage and use of the ironing board and other necessary items required by this work.

Recommended that double laundry tray be provided in utility rooms of all units with more than one bedroom where no central laundry facilities exist. A sink-tray combination should be provided in kitchens of all other units. — Livability Problems of 1000 Families

A place for drying laundry indoors is needed — a serious problem in winter. Diapers in kitchen are objectionable. No place for housework or hobbies. — Pennsylvania

Indoor drying space is desired by tenants—here contrived over the bathtub

Recommend provision of space for 40′ of clothes drying line for interior of all units with two or more bedrooms where no central laundry facilities exist. — Livability Problems of 1000 Families

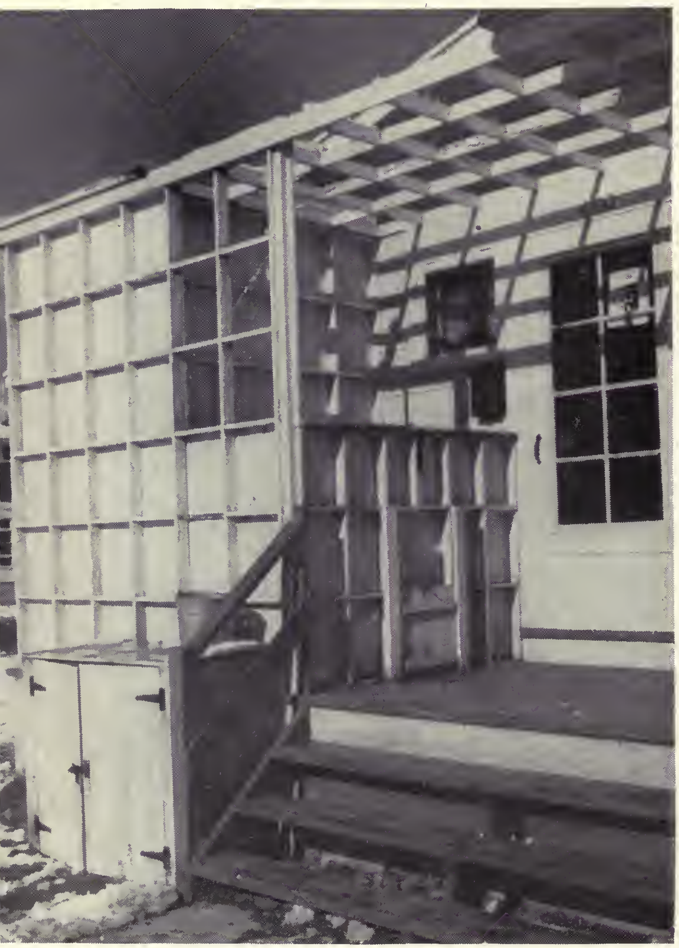
Garbage and Waste Disposal. Tall apartment buildings, and sometimes those only three stories high, justify the use of incinerators with disposal hoppers convenient for each unit; but this method is generally too costly for other building types. A variation of this system, used with success on some projects, consists of incinerators located at ends or sides of building, with hoppers accessible only from the outside. In all other cases refuse must be collected either at the units or from central stations, open or enclosed.

These various conditions have a greater bearing upon the site plan than upon the unit plan itself and are discussed in "The Site Plan". But the manner in which waste disposal affects the site layout will be reflected in certain elements of the unit plan as well, hence the decisions must be reached and co-ordinated at an early stage of project design.

Incinerators off apartment hallways are convenient

Effect of Fuel Upon Unit Plan. It has been noted that the nature of the fuel economically available is related to the dwelling type and that this relationship affects the manner in which the units themselves are planned. Coal is the fuel which produces the most serious planning problems and should be used for tenant-operated plants only in row and twin house units; in these plans, because of the dirt and inconvenience caused by the use of coal, the bin becomes an item deserving special attention.

The coal bin should preferably be designed as an integral part of the dwelling. It may be contained within the building or be combined with a porch or storage space to form an exterior feature. The height will be determined by the method of delivery and by the desired capacity. The floors of bin and heater room should be of concrete and should be flush where they join. The coal bin floor should have a slight slope to prevent drainage into the heater room.



This coal bin design relates to the house

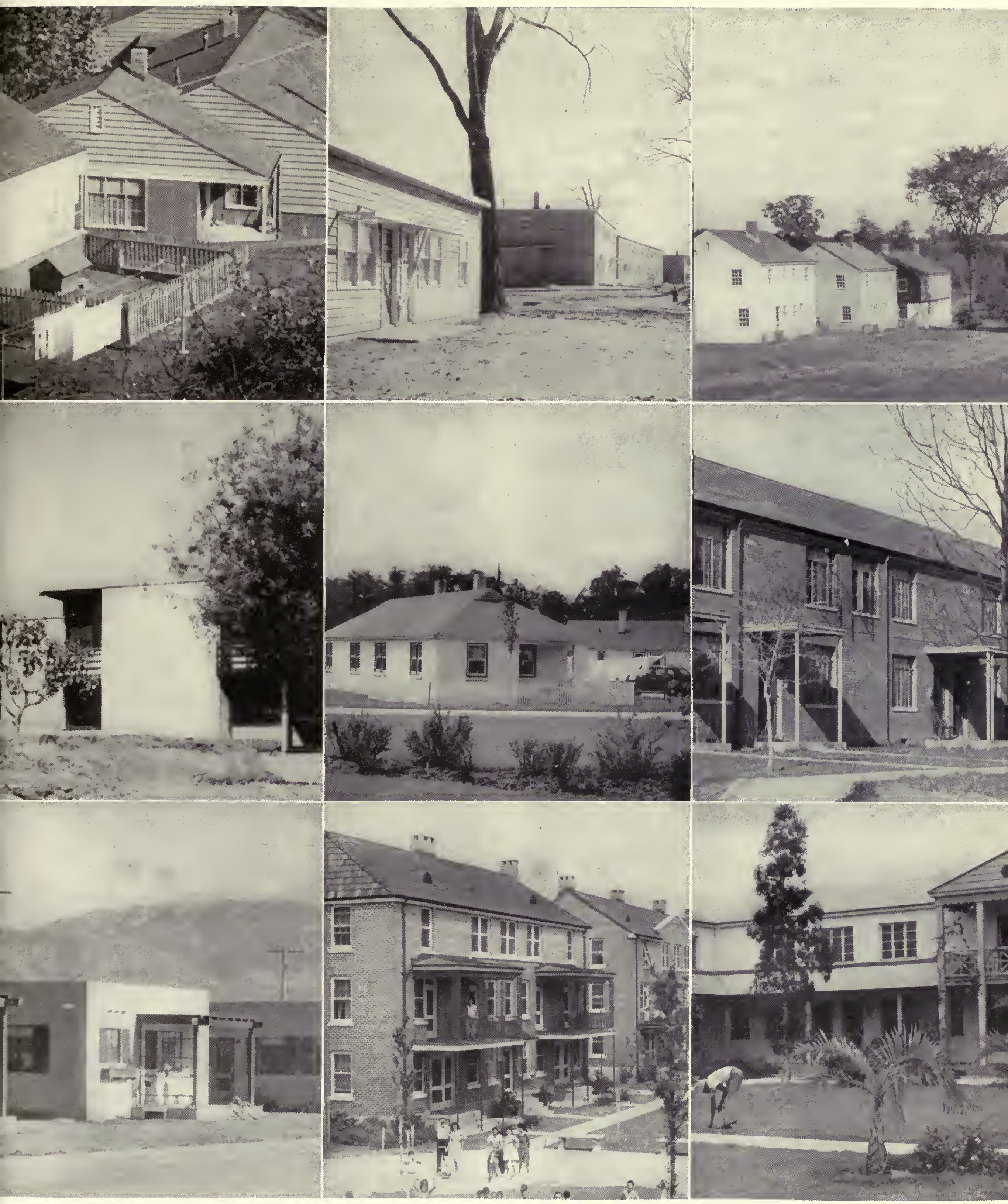
SPECIAL PROBLEMS

Esthetic Considerations. One may feel sure that no discussion of this subject would be attempted here were it not for the direct relationship that exists between plan and what is commonly known as architectural style. The subject is highly controversial and, in any event, the FPHA cannot appropriately hold opinions in the matter. It does, however, seem fitting to take note of what has occurred in the public housing program up to the present moment.

So far, it is safe to say that no distinctive movement in architectural expression has evolved from the program. True enough, many of the projects are stamped "public housing", but this seems due to the general use of standardized plans plus the enforced simplicity of structural design and exterior materials rather than to any inherent necessity.

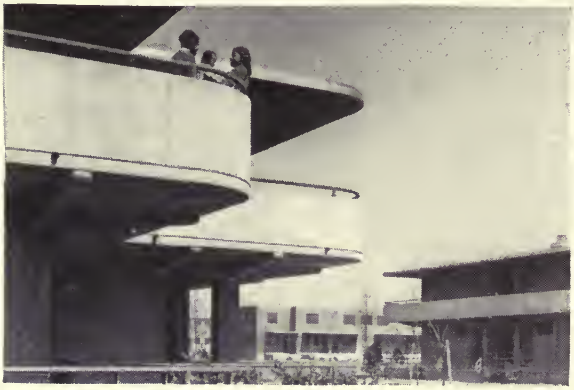
The proof of this seems to lie in the wide diversity of appearance displayed by the majority of projects throughout the country. The chief characteristics of these seems to be an attempt, deliberate or subconscious, to give to the buildings something of the local flavor.

Simplicity of detail and materials . . .

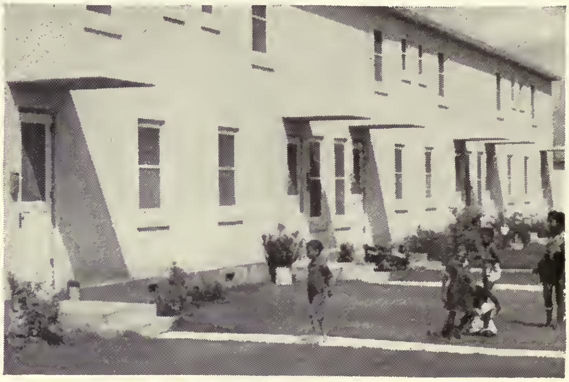


. . . does not prohibit housing from reflecting local patterns of architecture

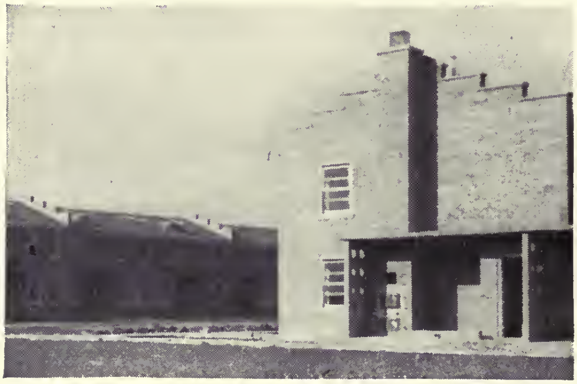
There exists, also, a category of projects in the design of which there is evidence of strong desire to give expression to function and personality. That these efforts have not yet reached their goal is proved by the extreme variety in approach and effect. Every conceivable device of form, color, texture, and detail seems to have been tried. To mention a few: strong horizontal lines produced by projecting galleries; overemphasizing parapets; banding windows together by means of dark colors in the masonry between; thin slabs of projecting concrete to throw deep shadows in contrast to plain wall areas; heavy quoins (that attract climbing children); primitive ornament in relief at doorways and elsewhere; and lavish use of colors, sometimes startling in their contrasts. While many of these projects are interesting to a degree, few if any seem to say: "This is a solid solution to public housing design."



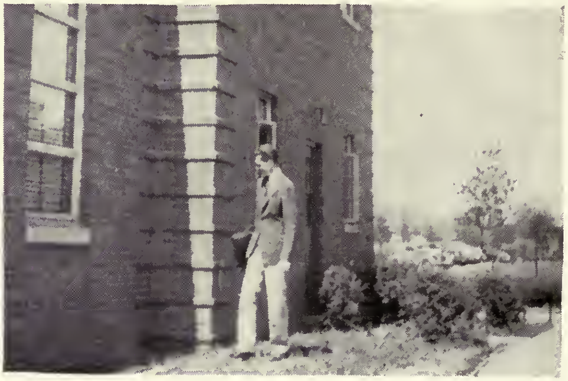
Deep galleries



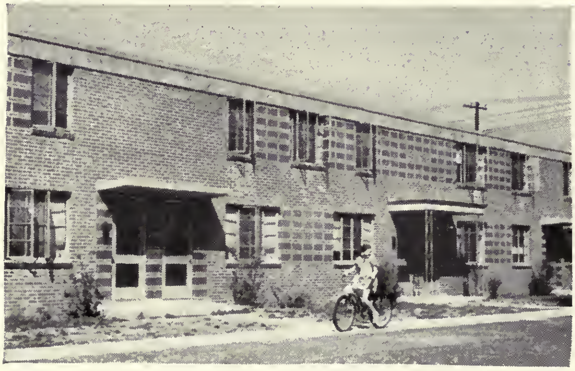
Thin slabs of projecting concrete



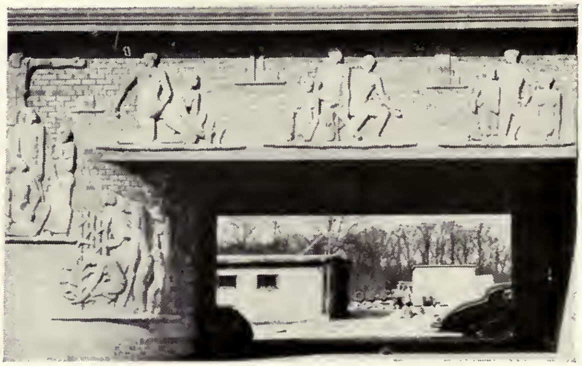
Overemphasized parapets



Brick quoins



Dark bands between windows



Bas-relief at an entrance

Finally, there are a few projects where the architects quite evidently were seeking neither for indigenous qualities nor functional expression, but were attempting to force architectural effect into a problem which does not benefit from striving: such efforts not only have failed but nearly always have laid an unnecessary burden of cost upon the projects.

Free Planning. This is a term, used for want of a better one, to identify that new school of thought which seeks to use space unhampered by its conventional division into rigid rectangles and cubicles, and thus to give more unity, spaciousness and meaning to whatever is being planned—in this case, the dwelling.

So far, this philosophy in planning has not been encountered often in public housing work, but it may be expected that it will appear in the future. As in the case of architectural style, the FPHA takes no position one way or the other, but it has recognized the possible advantages in such planning through the manner in which the "Minimum Physical Standards" are worded.

Perhaps all of this forecasts great advances in planning techniques and resultant livability; but it might be well to proceed slowly in light of the rigidity of family habits shown by such surveys as the "Livability" study quoted above.

Basements. This is another fine field for controversy. Do basements increase costs? If so, how much? And in any event are they worth while? Basements have been so rarely used in public housing, except for apartments and, occasionally, for flats, that experience affords no precise answers to any of these questions. It is probably fair to say that their use may involve an increase of from five percent to ten percent of total construction cost, dependent upon many conditions, but that their value is too great to warrant omission without careful thought. These points, at least, should be pondered, and it would be well to prepare alternative sketches and estimates before abandoning the idea:

1. Basements solve the general storage and laundry problems, and their increased cost is offset in part by the saving of storage and heating spaces on the first floor. However, since space requirements for the second floor are greater than those for the first floor, planning is complicated unless one or more bedrooms are placed on the first floor.
2. Basements provide an excellent place for rainy-day play and for pursuit of adult hobbies.
3. The most efficient and economical place for the heating plant is the basement. If coal is the fuel, outside coal bins are avoided; but, on the other hand, outside stairs are desirable, though not necessary, for ash removal.
4. Basements facilitate termite control.
5. Greater depths of excavation for both basements and sewers are required; but this can be minimized if architects are prepared to accept higher elevations for first floor levels.
6. There are only two alternatives to the basement: the slab-on-ground first floor and the crawl space between grade and floor. The first is much the cheaper; it has certain objections, but most of these have been pushed aside by cost considerations. The crawl space has been one of the sore spots—perhaps the greatest—in public housing. Dampness; deterioration of structural parts; space where termites work and dangerous gases accumulate; and inadequacy of repair space are all cited in loud tones when housing managers get together.

The above is not to be construed as a pointed or even subtle argument for basements; it would be foolish to advance this in face of cost limitations that apply. But experience does prescribe that much thought and skill be brought to bear on this problem, so that either the advantages of basements may be had by clever planning and by curtailment of unnecessary expense elsewhere, or the low cost of crawl spaces may be gained without the difficulties which have formerly attended their use.

Porches. Here is still another moot question. Are porches really used or are they merely for architectural effect? Is their value as usable space offset by the undeniable fact that they block sunlight? If used, should they be placed in the front or the rear of the house? In any event, is their cost justifiable? The following may at least aid in arriving at sound answers:

1. Their use appears to be somewhat a matter of geography: in the South, where people somehow seem to find time to sit outdoors and the climate encourages this pleasant pastime, porches are desired by nearly all tenants. As one moves further north the use, and consequently the demand, for porches becomes less. When architectural effect is the motive for porches they often are so reduced that they afford little practical use.

Families sit on porches, especially in the South

2. Since strong sunlight is more needed in the North where porches are less used, this question seems to answer itself.
3. Tenants want porches to face the street where they can see all that goes on. If the porch is at the rear, the family will use it, but they prefer it on the front.
4. The matter of cost can be judged only for each local condition. In any event, if there are no porches, some form of canopy over entrance doors is essential for weather protection; and this point should be taken into consideration when the question of porches is being weighed.

90 percent of families want porches, especially front porches. This desire is more pronounced in the South.

One porch serving two families is objected to by tenants and by managers. Families want their own porches. — Livability Problems of 1000 Families

Canopies are so small that rain drives in, damaging floors. — Texas

Stoops: Should be large enough to accommodate three or four chairs. — Connecticut

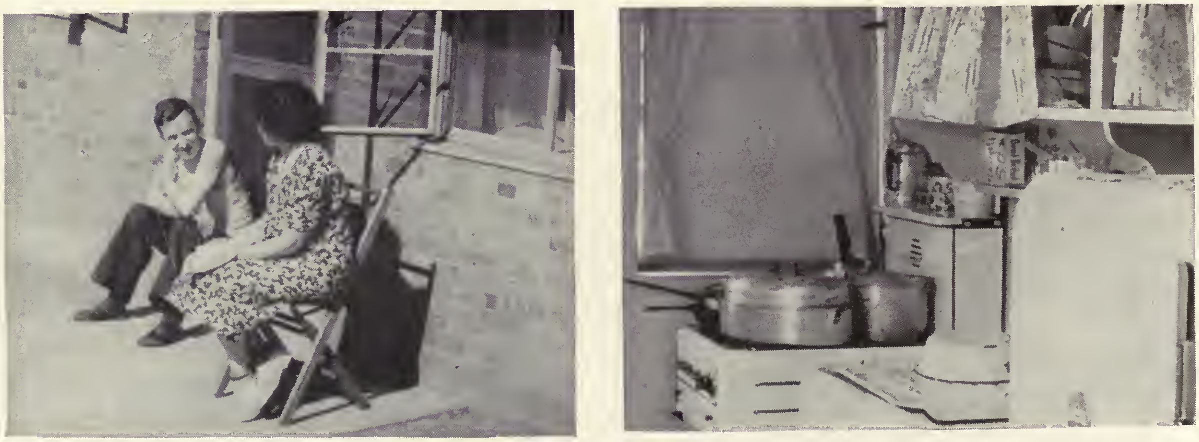
Back porch, when oriented for privacy and sunny breezes has endless uses (vegetable rinsing, family wash, canning, meals, sitting, sleeping for children). — Technical Division Report

Porch roof or canopy: Reviewer considers this desirable, as houses built without look a little shacky, even those built of masonry. — North Carolina

Household Safety. This is a matter to be given thought during every stage of project design and especially in unit planning. There is no need to recount the number of household accidents—and resulting deaths—or to detail their major causes: many of these, it is true, are not the result of thoughtless planning, but at least many can be avoided by the plans. Winding stairs, lack of railings, low casements, single steps, doors that swing toward and over steps, poor lighting at hazardous locations, conditions which prompt the use of ladders, slippery floors, shelves over and curtains close to ranges, badly placed electric switches and outlets; these and hundreds of other such items are to be avoided. Certainly the architect and engineer cannot prevent carelessness on the part of tenants but they can be aware of the problem and can do their part to minimize its effects.

There should be handrails at entrances having four or more risers. (One manager says two or more). Lights needed at front doors. — Regional Report

Heating unit in utility room is too crowded for easy maintenance; presents a potential fire hazard. — Regional Report



Three hazards to be avoided: steel casements swinging low on terraces, shelves over ranges and ranges next to windows

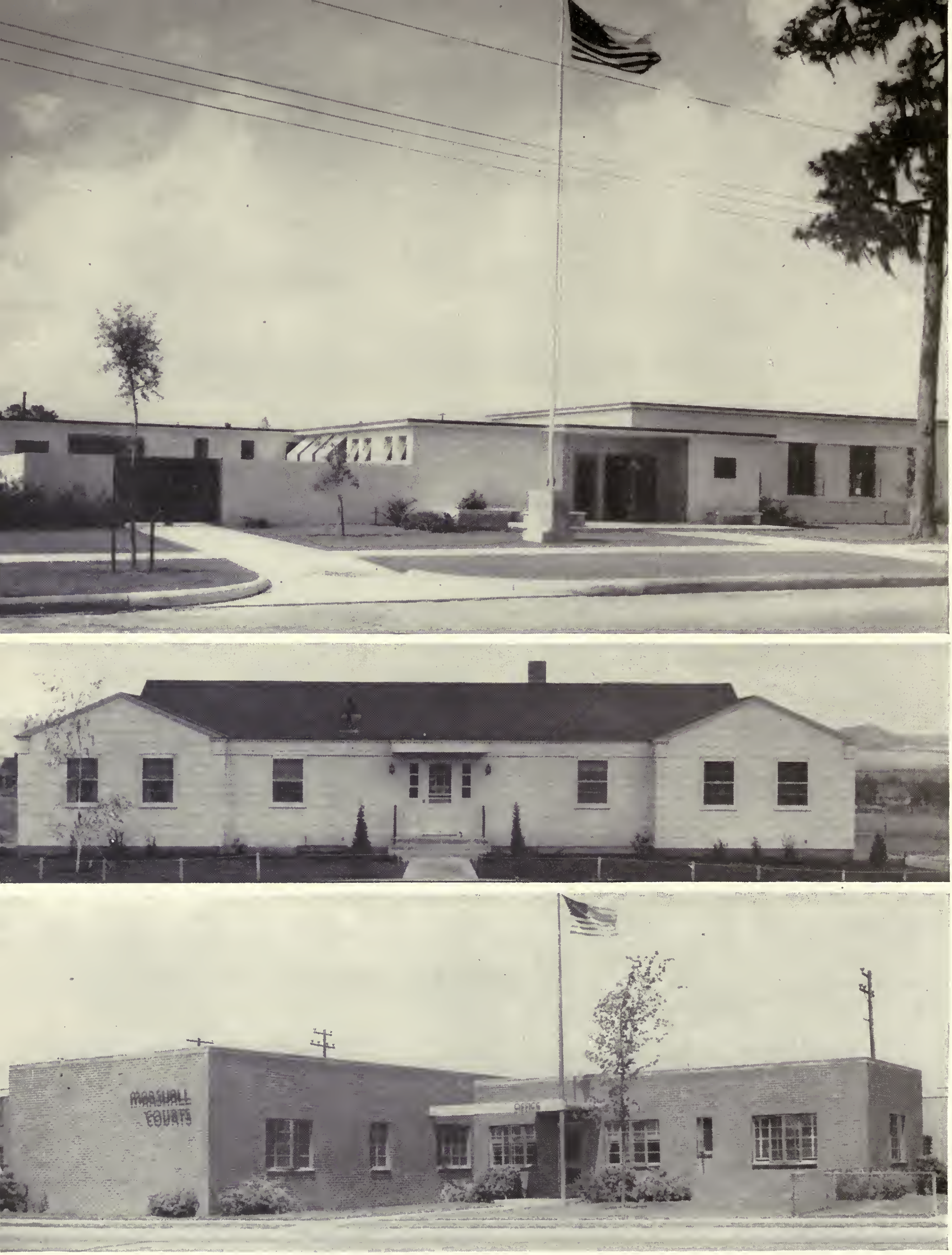
Community Buildings & Other Service Structures

THE planning of community buildings for public housing projects is a relatively new field in this country, and one for which little precedent existed in European public housing experience. For this reason much of the planning up to the present time has been inevitably by the trial and error method. Many local housing authorities, however, have now had sufficient experience in project operation to develop plans for management and maintenance buildings which they find satisfactory. Many of them have also, either independently or with the help of community service agencies, adopted definite policies as to the types and design of buildings for community use which should be provided on the site.

Reports from these authorities show a wide diversity in methods of project operation and in local policies with regard to community facilities. The reports also show that many changes have taken place in methods of project operation and in policies on community facilities, when local conditions have changed or when experience has indicated the need for change. More changes may be expected as the future housing program reflects the problems of transition from an economy geared to war production to an economy adjusted to peacetime requirements.

A diversity in the types of facilities required and a flexibility in their design are implied, therefore, which rule out at the start any "standard plan" as the one solution to all problems of community building design.

Community building in a Northwestern development



Community buildings: designed for the South (top), the Rockies (center), the East Coast (below)

The frequent recurrence of certain problems, however, which appear to be directly related to the types of facilities provided, or to their location or design, suggests that a summary of recommendations and warnings based on experience with community facilities in a number of projects may help the planners of future community buildings to avoid some of the features responsible for these problems.

The following summary of recommendations has been prepared with the hope that its use will tend to prevent the repetition of the more common errors of the past. It is intended primarily for those who will be planning community buildings for the first time. Those who have had experience in this field will, it is hoped, already have profited by their own experiences, but they also may find they can learn something from the mistakes and successful solutions of others.

Some of the recommendations included in the summary may be so simple and self-evident as to be irritating, but, however simple they may be, few were self-evident to all designers of community buildings eight or ten years ago — in the early days of the low-rent housing program in this country—or even four years ago, when the war housing program was initiated.

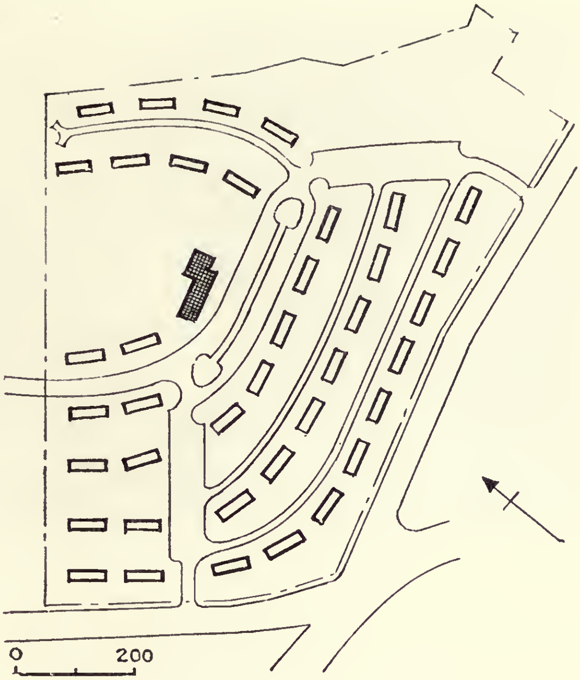
TYPES OF FACILITIES REQUIRED

Community facilities commonly provided in public housing projects, in addition to outdoor recreation areas, include management offices, space for maintenance shops and storage, and one or more community rooms for the use of project tenants. Spaces for child-care centers and health clinics also are provided frequently, either in the community building or in separate buildings.

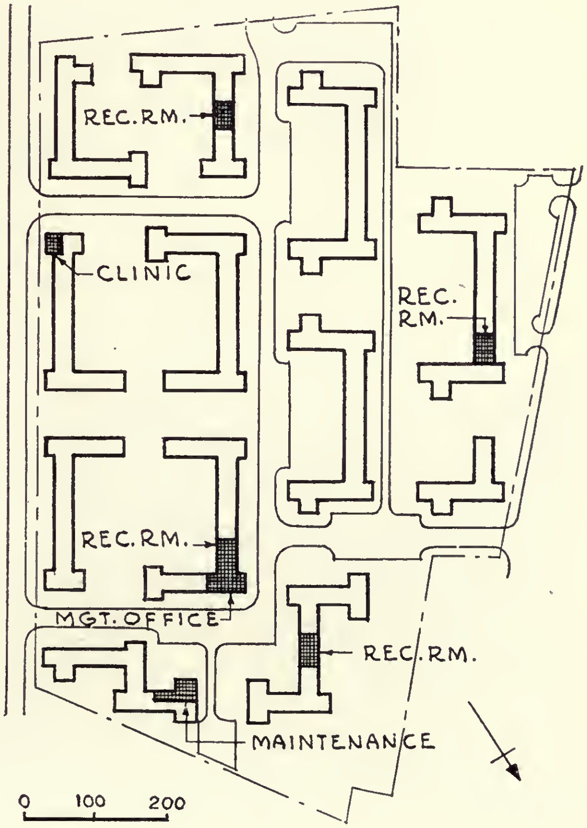
Additional facilities occasionally required for very large or isolated projects include commercial facilities, schools, post offices, fire and police stations. The buildings required for these purposes are usually constructed off-site by private enterprise or by public agencies other than the housing authority.

PRELIMINARY PLANNING CONSIDERATIONS

Grouping and Location. The advantages of grouping all community buildings closely together and locating them at the principal recreation area, already mentioned in "The Site Plan", cannot be overemphasized. Dispersal of these facilities tends



Community facilities: Centralized and conveniently located (above); scattered in dwelling buildings (below)



Community building adjoining the principal recreation area

to increase construction and operating costs, and frequently has resulted in almost insoluble problems of supervision.

> Decentralized social rooms are satisfactory for adult activities where responsible tenant leadership is available, but they can't be used for children's programs because it is impossible to get a separate supervisor for each one. If all these rooms had only been combined into one building, we could have had an adequate program of community activities. As it is, we simply had to close most of the rooms. — New York

An exception to the general recommendation for locating all community facilities at the project center is maintenance space in projects which have heating plants located, for some reason, away from this center. In such cases maintenance space often has been placed in or near the building in which the heating plant is located in order to simplify the work of the maintenance engineer, who, in most instances, is responsible for general supervision of the heating plant as well as of other maintenance work.

Relation to Other Community Facilities. Where a public playground or neighborhood park is included within the project boundaries or where the project site borders such an area, the most desirable location for rooms intended for community activities usually is close to the public recreation area. Projects in which this location is not convenient for management offices and maintenance space constitute another exception to the general recommendation for combining or closely grouping all community facilities at one place. Since the advantages of proximity to the public recreation area normally outweigh those resulting from closeness to other facilities the rooms for community activities may be built as a separate structure on or adjoining the public park or playground. In one city the Recreation Department, with the approval of the City Council, deeded to the housing authority a site for such a building on land purchased for a public playground bordering a public housing project.

Occasionally a school, or a shopping center built by private enterprise, has been included within the boundaries of the project. In one instance, where both a school and shopping center are located within project boundaries, the local housing authority, in co-operation with the parties responsible for these facilities, developed a plan for placing them at the project center. See "Outdoor Recreation" in "The Site Plan." This is a very desirable arrangement, since it is convenient for the tenants, and has the further advantages that the principal play area of the project serves also as the playground for the school, and that the school auditorium and gymnasium can be used for large tenant gatherings.

Supplementary Buildings. One or more supplementary buildings may be required in projects where, due to the shape or size of the site, or to its intersection by a heavy traffic artery or railroad track, or to topographical features, the central building group can not conveniently be reached from one or more parts of the project. Yard stations, for example, are sometimes located in different parts of a project for the storage of lawn mowers and other grounds maintenance tools loaned to tenants or used by the project maintenance staff. Toilet facilities and storage space with a playroom or covered play porch are usually desirable in connection with a secondary play area.

General Organization of the Plan. The planning of a community building presents problems somewhat comparable, on a small scale, to those which must be solved in the development of an efficient international government without violating the sovereignty of the participating nations.

The plans should always be designed from the beginning in consultation with the local housing officials who will be responsible for the various phases of project operation. Managers have sometimes complained about the design or arrangement of offices. The waiting room, for example, may not be large enough to accommodate tenants on rent-collection days. Advance consultation with managers will tend to obviate such difficulties.

All community rooms should be planned in consultation with representatives of community agencies expected to provide leadership for welfare and recreational programs in these rooms. Failure to consult with representatives of these agencies has resulted sometimes in the construction of facilities which the agencies find difficult to operate. When confronted with problems due to the design of the building they have often asked indignantly why they were not consulted.

Since changes in the method of operation and in relationships with community agencies frequently take place after a project is occupied, however, a flexible plan which can be adapted readily to a variety of uses is likely to be more satisfactory in the long run than one designed to meet highly specialized requirements.

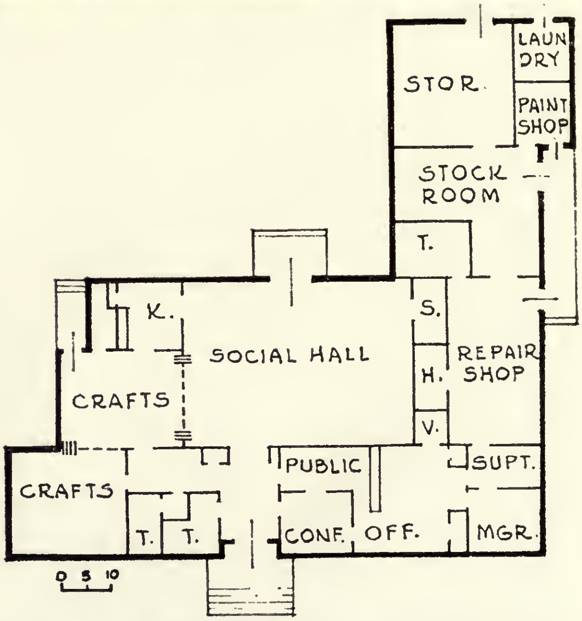
A community room planned for more than one use

An arcade connects management offices with community hall

DESIGN

Preliminary Plans. One of the major problems is to reconcile the need for sufficient separation between the various facilities accommodated to prevent friction and confusion in their functioning with the need for proximity between them to keep construction and operating costs within reasonable limits.

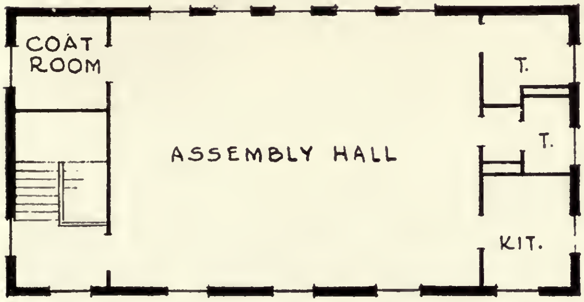
A close grouping of the rooms required for each of the facilities accommodated, forming a unit which can be operated independently, tends to promote harmonious relations among the people using the various parts of the building. Sources of possible irritation are very much reduced by providing for efficient circulation between and within these units, and by the strategic location of rooms which require a certain amount of quiet in relation to



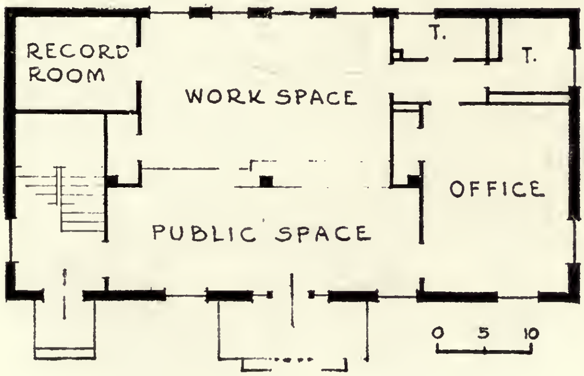
A compact plan providing convenient circulation and good separation between the various spaces those which will be used for noisy activities.

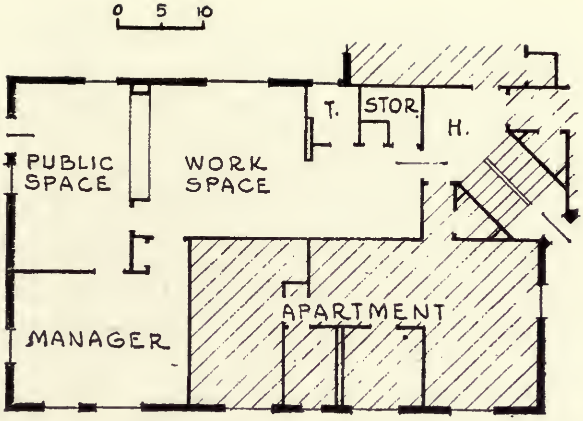
A convenient connection between management offices and the spaces provided for both maintenance and community use is usually desirable to facilitate supervision or co-ordination of activities. Failure to provide for direct and convenient passage between these parts of the building creates a variety of problems. Halls and lobbies which cannot easily be supervised cause numerous headaches. The lack of halls, where needed, may create equally serious difficulties, if it necessitates the use of rooms, such as storage rooms or social rooms, as passageways from one part of the building to another. In some localities arcades and covered porches are considered satisfactory substitutes for part of the interior corridors and lobbies.

A satisfactory relationship between rooms used for different types of activities is essential for a successful plan. The location of management offices over or under community rooms of any kind, for example, invites trouble and in some instances has resulted in so serious a curtailment of the use of the community rooms as to necessitate the construction of additional community facilities elsewhere. Similar problems may result from the location of maintenance repair shops under or adjoining management offices or community rooms requiring quiet. The use of sound-deadening materials in ceilings, floors or partitions between the rooms which require quiet and those from which the disturbances emanate provides sufficient protection in some instances, but may not be adequate when windows are open during warm weather.



The assembly hall over management offices invites trouble





Management offices adjoining living quarters need sound insulation

The location of community facilities of any kind under or adjoining dwelling units calls for the use of effective sound-deadening materials in the walls or floors which separate the facilities from the dwelling units.

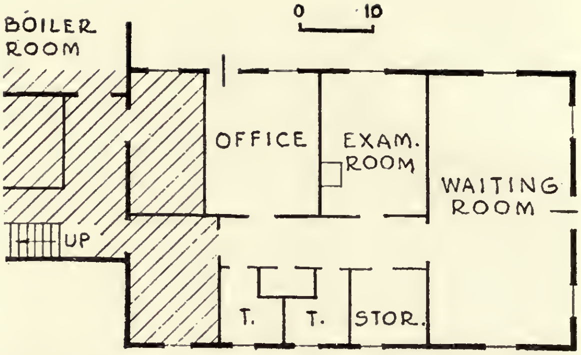
Orientation. The need of a southerly exposure for rooms intended for small children's play programs is the most important consideration in the orientation of the building if it includes rooms which will be so used.

A direct western light for management offices is generally disliked. A location which has a north or northeastern light is most favorable for the examining room of a clinic. In most parts of the country, however, a good exposure to the prevailing breeze is generally considered more important for most rooms (especially the management offices, maintenance shops, community hall and kitchen) than a particular exposure to sunlight.

Entrances and Exits. A very important consideration in the design of a building used as a place of assembly by the public is to insure safe and adequate exits for use in case of fire. The entrances to management offices, maintenance space and many community rooms, particularly the community hall and rooms planned for small children's programs, are placed preferably at or near grade. Basement space has been used for these purposes but has many disadvantages unless a sharp change in grade permits entrance at or near grade on at least one side.

Too many entrances increase the problem of control, but lack of outside entrances where needed creates other problems of operation. Separate entrances to the parts of the building used respectively for management offices and community rooms usually are preferred to one entrance serving both parts. A common lobby, however, with one outside door, may serve as a satisfactory entrance to both of these parts of the building if (1) each part is connected with the lobby by means of a door which can be locked when desired, and (2) if the lobby and outside entrance can be supervised easily from the management offices.

Maintenance space usually requires a service entrance not less than five feet wide for delivery of supplies and for taking large pieces of maintenance equipment in and out of the building. An additional door of normal width is also desirable for the convenience of maintenance employees.



Health clinic with its own entrance

A separate outside entrance, or location close to an outside entrance to the building, is usually preferred for rooms used as libraries, public health clinics, and for child-care programs.

Rooms for large gatherings need plenty of exits for safety

A covered entrance gives shelter from sun and storm

Kitchens need a convenient service entrance, or a location close to such an entrance.

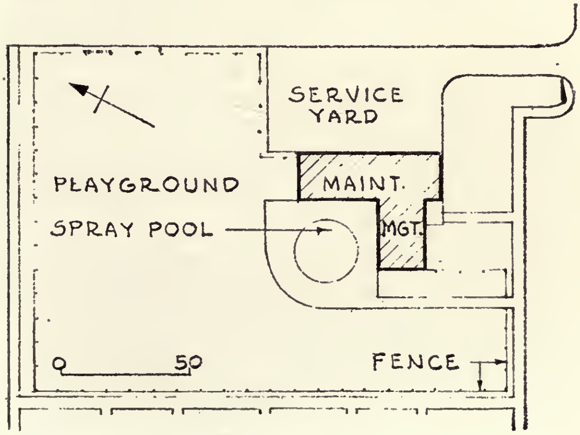
Correlation of Plan with Related Outdoor Area. Occasionally a manager prefers an office that overlooks a play area. More frequently, however, management offices should be located away from noisy play areas, for the mutual benefit of office employees and children.

A wide paved space at the entrance to management offices is desirable for parking baby carriages, and is particularly satisfactory if it is covered in whole or in part to afford shade from the sun and shelter from rain and snow. The paving should not, however, extend under the windows of management offices.

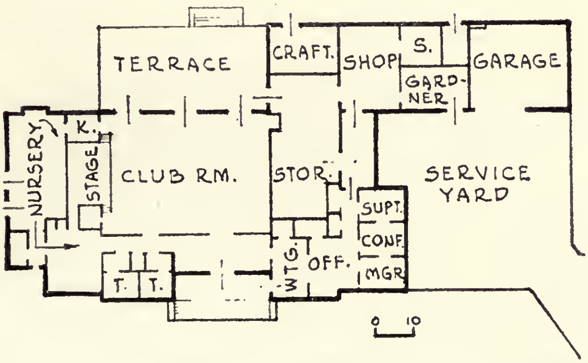
Space is needed nearby where management staff, tenants and visitors, may park their cars.

Maintenance space should be located so as to afford a convenient approach for delivery trucks. A fenced service entrance court has been found useful in many projects for parking and servicing motorized maintenance equipment, for temporary storage of supplies and, during warm weather, for use as an outdoor workshop. The service court preferably should be placed where it is visible from either the maintenance supervisor's office or (in a small project) the manager's office.

The preferred location for community rooms is towards the principal play area. Separation of these rooms from the play area by a parking lot, service court or drive creates hazards, prevents an effective correlation of the interior plan with the design of the recreation area, and needlessly complicates the problems of supervising a recreational program.



Unsatisfactory relation between spray pool and management offices



Good relation between maintenance shops and service yard

A paved terrace is always popular

Even a through project walk preferably should not separate the community rooms from the play area.

A paved terrace directly outside the door or doors leading to the play area is a popular feature which lends itself to numerous uses in connection with both indoor and outdoor recreation programs, such as crafts, dances, parties, storytelling, and games requiring a hard surface.

Most directors of programs for small children like to have the playrooms open directly on a fenced, partly paved play yard.

Managers and recreation directors are almost (but not quite) unanimous in asking that toilets for both young and older children be so located that they are convenient to the play areas provided at the community building. They are by no means agreed, however, as to the best arrangement for entrances. Some recommend doors opening directly into the toilets from the playground. Others have found this quite unsatisfactory and prefer a plan in which entrances to toilets are from a hall or lobby which can easily be supervised by someone in the building.

The recreation director's office should be located near a door leading to the play area, and preferably should have a window overlooking the play area. Storage space for portable playground equipment should be located near the entrance of the community building leading to the playground. Control of supplies is facilitated by planning this space as a closet directly connected with the recreation director's office.

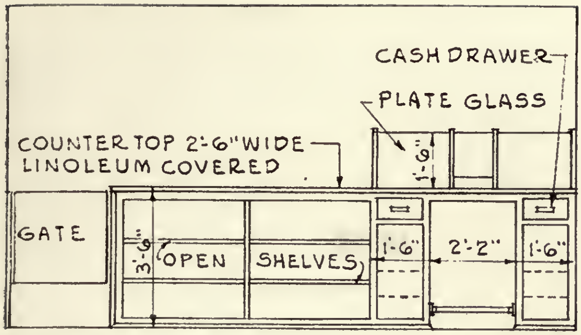
Room Relationships and Design Details. The design of the rooms to be used for each of the facilities provided must be developed, of course, in accordance with local methods adopted for operating these facilities. Certain relationships between the rooms, however, and specific features in their design appear to contribute to the efficient operation of various facilities, irrespective of local differences in management and maintenance methods or in the sponsorship of community programs.

Management Offices. Rooms usually provided include (1) waiting room, (2) general office, (3) one or more private offices, depending on project size and management methods, (4) storage space for office supplies, (5) coat closet, (6) toilet facilities, and (7) a vestibule in cold climates.

In some localities a rest room for women employees is required by law. This is usually a desirable feature for any management office. Where one is not provided, makeshift arrangements frequently have had to be made.

A small room where project employees can eat lunch is a great convenience on a project located at some distance from a good lunchroom.

Convenient circulation between rooms is essential. The general office, which serves as the principal point of communication between the management



Counter between office and waiting room, from office side

and tenants, usually is separated from the waiting room only by a counter with a protected cashier's window. This provides a convenient place for holding informal interviews, giving out information, filing applications and complaints and performing similar routine management tasks. A close relationship between the general office and all other offices usually is desired. Many managers recommend a direct connection between manager's office and general office. Easy access to one private office, at least, from the waiting room is desirable.

The storage space for office supplies, which is frequently used for filing office records, storing portable equipment and the office safe, should open directly into the general office for convenient use and effective supervision by office employees. A location where visitors and maintenance employees will not pass directly by its door is suggested as a means of facilitating supervision. Proximity of this space to the cashier's desk is recommended by some managers. Construction of this room preferably should be of fireproof or fire-resistant materials. One manager suggests that it should also be equipped with a burglar alarm.

Entrance to toilets from a hall with access from all offices is preferred to entrance directly from any one office. Employees particularly dislike a location of toilets which permits visibility of the doors from the waiting room. A location adjacent to the manager's office should be avoided. Toilets planned to serve both management and community space usually have been reported unsatisfactory.

A coat closet in every office is desirable; but if this is impracticable, one closet should be located where it is accessible from all offices which are without individual closets.

The proportions of the rooms and the location of doors, windows, radiators, and other fixed equipment should be planned to permit an efficient arrangement of desks and other office furniture and equipment. Good natural lighting for the counter and office desks is particularly desirable.

Managers dislike exposed concrete floors. They prefer hardwood or asphalt tile, laid on wood or concrete. The use of durable materials and a washable finish for walls and woodwork, especially in the waiting room, reduces maintenance costs.

A bulletin board in the waiting room and one just outside the management entrance are useful for posting announcements and information of general interest to the tenants.

Maintenance Space. Rooms usually provided for maintenance purposes include (1) one or more repair shops, (2) storage room, (3) paint shop, (4) toilet, shower and locker room, (5) a superintendent's office in large projects.

In some projects it has been found necessary to provide a separate and convenient place where the employees may eat their lunches. This promotes a good relationship between management and employees and has the very practical advantage of preventing the scattering of crumbs and other refuse which attract vermin.

Direct access to the repair shop from the service entrance and convenient access to storage space and paint shop from the same entrance is recommended by managers. Storage space for lawn mowers and other grounds maintenance tools loaned to tenants, however, preferably is located near the employees' entrance. Proximity of the maintenance superintendent's office to the service entrance is desirable. If no such office is provided, the plan should provide

Counter, looking from the waiting room toward the general office

space for a desk near this entrance for convenient checking of supplies and equipment coming into or leaving the shop.

A direct connection between repair shop and storage room facilitates the transfer of items which need repair and temporary storage. Managers warn against plans which require the use of the storage room as a passageway from one room to another, however. Danger of theft is reduced by planning it so that is can be locked.

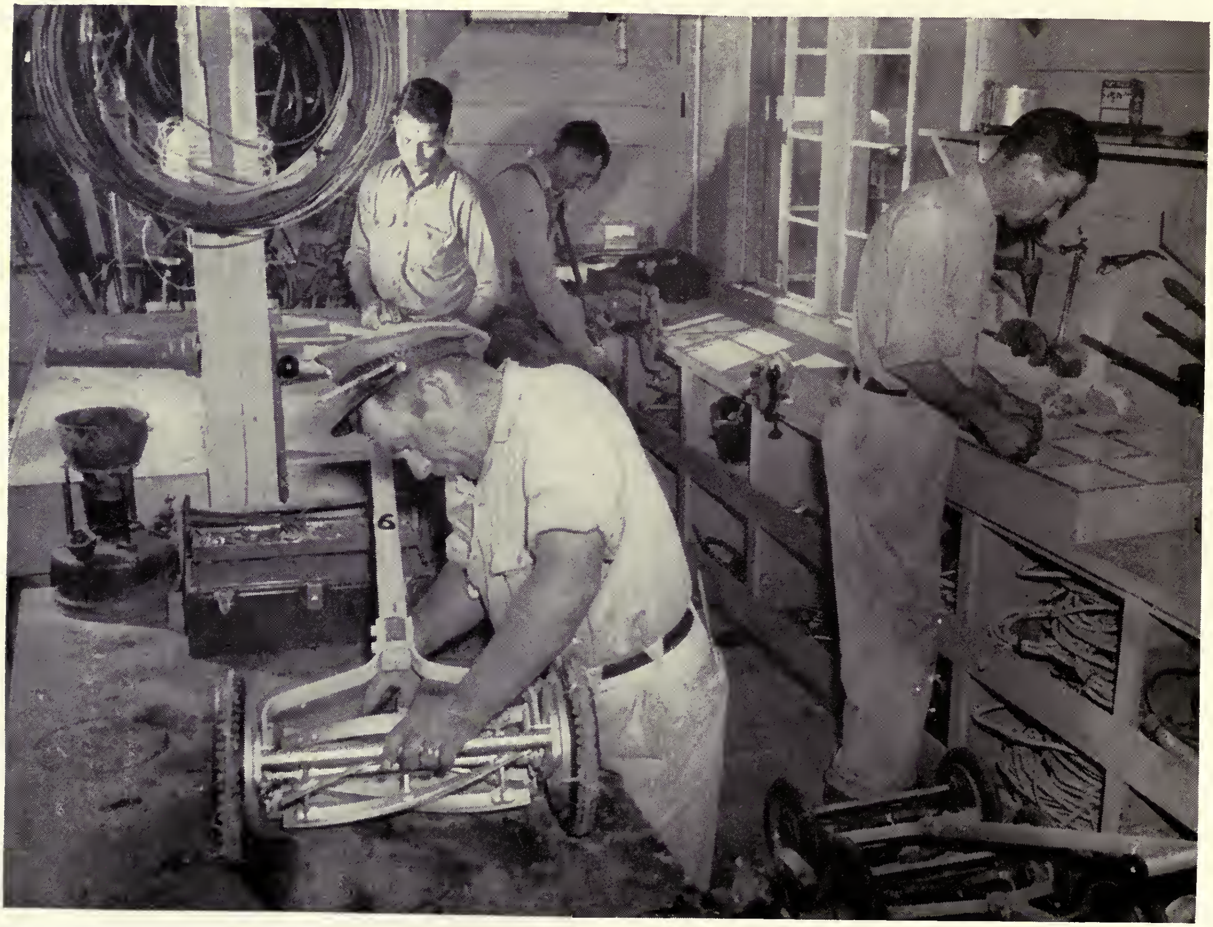
The paint shop normally is used only for the storage of paint, inflammable painting supplies and small equipment. Fire-resistive materials should always be used in partitions and ceilings of the paint shop, unless it is a separate structure. Whether used for paint storage only or for painting and storage, the paint shop should be equipped with incombustible furniture, shelving, bins and benches and should be protected by automatic sprinklers. In some localities fire insurance rates are reduced if the shop has an outside entrance only, or if it is built as a separate structure.

Good ventilation is required for all rooms, and good lighting, both natural and artificial, for all work spaces. The proportions of the repair shop and the arrangement of doors and windows should be designed to permit a favorable location of workbenches and other fixed equipment.

Concrete floors, preferably with floor drains, are generally considered satisfactory. Walls and ceilings that can easily be cleaned and that are not easily damaged tend to reduce maintenance costs.

Rooms for Community Use. Rooms commonly provided for community use include: (1) a community hall, (2) one or more smaller social rooms (except in very small projects where the com-

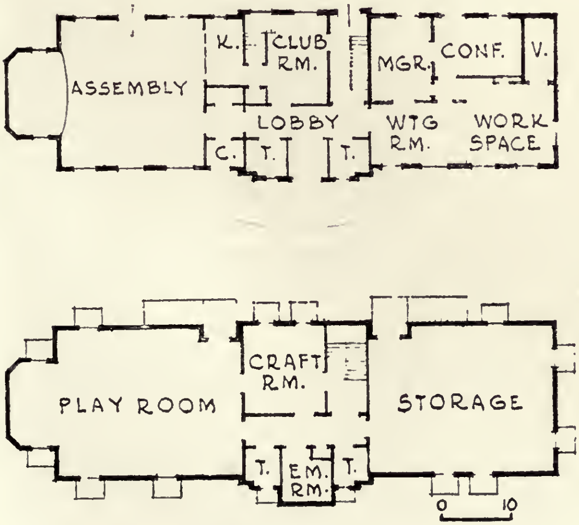
Good light is essential for workbenches



A well-lighted arcade reduces the need for supervision

munity hall is the only social room), (3) a kitchen, (4) toilets, (5) storage spaces, including coat room, janitor's closet and storage closets for supplies and movable equipment, (6) a lobby.

A recreation director's office is also desirable. In some projects where it was not planned for, managers have had to adapt space for this purpose.



A plan arranged for effective supervision

A plan which permits effective supervision from a central point is recommended by community recreation directors. Supervision is facilitated by the use of an entrance lobby (extended by corridors in a large building) as a means of access to all rooms except storage closets, and to adjoining play areas.

The lobby affords the most satisfactory passageway from community rooms to management office. It is the best place for a drinking fountain, and a telephone booth located there is a convenience for tenants. Recreation directors warn against long, narrow or circuitous corridors, alcoves, dark corners, and the use of social rooms as passageways from other social rooms to toilets or to outside entrances.

Bright lights in halls and lobbies reduce problems of supervision. Arcades and covered porches which may replace or supplement interior lobbies and corridors also should be well lighted.

> Above all, don't skimp on electric lights. — Washington State

Craft work needs plenty of space and good light

A country dance in a community hall

The advantages of planning for flexibility in the use of the community building have already been stressed. This is particularly important in the design of rooms intended for community use since the space that can be provided almost invariably is limited in relation to the need. In addition, frequently the kinds of activities and programs that develop after a project is occupied not only differ radically from those anticipated, but also change from time to time in response to fluctuations in tenant interest or the types of leadership that are available.

Programs carried on in community rooms in public housing projects include: Sunday school and church services, children's play programs, homemaking classes, health clinics with special emphasis on well-baby clinics, clubs for adults and children, teen-age programs, sewing, crafts, furniture repair, branch libraries, meetings, art classes, concerts, dramatics, dances, lectures and community suppers.

The community hall in a small project may be used for a number of these programs in turn, and therefore should be planned for very intensive use. In larger projects where one or more additional social rooms are provided for rather specialized use

The community hall is sometimes used for a well-baby clinic

Storage space for movable equipment is needed in the well-baby clinic

Branch libraries require space for tables and chairs as well as for books

the community hall, and usually the other rooms also, must be adaptable to a variety of uses. Many managers and recreation leaders emphasize the need for a large community hall.

> The most important thing is to have one large community hall. It may be planned for subdivision, but should be large enough to permit the manager to meet with a considerable number of the tenants at one time to discuss maintenance problems. — Virginia

> A large community hall is essential for a long-range slum clearance program from a strictly selfish point of view. If we are to keep rents low, maintenance and repair costs must be kept low, and the only way to do that is to get the people together for education in the proper use and care of equipment, and also to convince them of the good faith of the Government as landlord. Then too, if they have a place where they can get together for social activities and recreation there will be less wear and tear on the dwelling units. — Virginia

Sliding doors provide flexibility

Some managers have reservations, however, as to the desirability of a large hall. On some projects, they have reported that large gatherings and dances have been held only occasionally and that activities initiated by most tenant groups have been served better by several smaller rooms.

> We don't need a large community hall here. Several small rooms for clubs and parties are more satisfactory than one large room. — Maryland

The adaptability of rooms for diversified programs is very much increased by the use of folding partitions for subdividing large social rooms and by providing ample storage space. Provision of several shallow closets (not more than two feet deep) opening directly into each room and equipped with doors that can be locked, permits each group using a room to lock up supplies needed for its particular program. A relatively large space is needed near the community hall for the storage of chairs and other movable equipment.

A fixed stage with dressing rooms adjacent, and preferably a backstage connection with toilets, increases the usefulness of a large community hall. The design of one end of the community hall to accommodate a portable platform is recommended for halls not large enough to justify a permanent

A social room doubles as a craft room

One social room may be used for various kinds of fun at the same time.

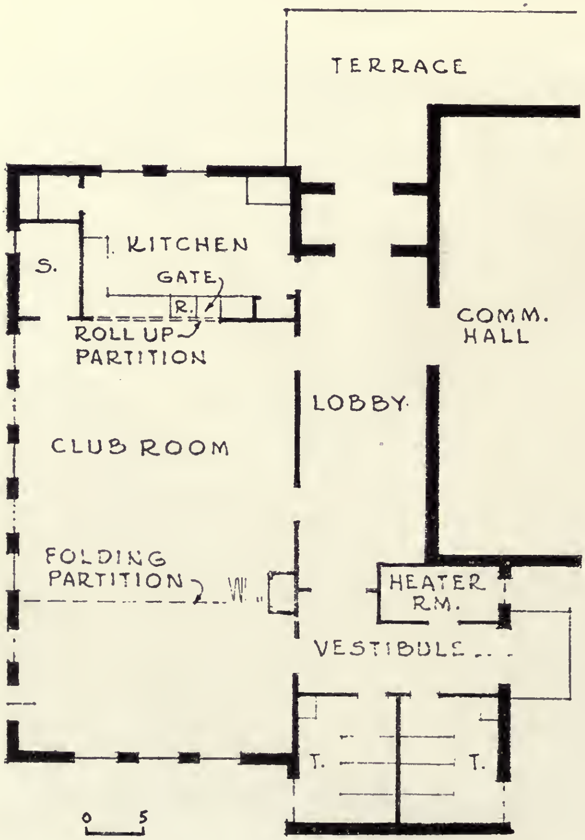
stage. Special storage space usually is needed for a portable platform.

Acoustical material in the ceilings of community halls is requested by recreation directors and managers practically everywhere. Many of them also recommend the installation of a motion picture projection booth. The director of one housing authority found it necessary to install wiring for loud speakers, in order to adapt the room to meet the recreational needs of project tenants of all ages.

> As incomes decrease the people will have to depend increasingly on the recreational resources in the project. Movies are by far the most popular form of entertainment. — California

When included, the projection booth should be separated from the auditorium by fire-resistive partitions.

A direct connection between the kitchen and an adjoining social room (preferably not the community hall, unless it is the only social room) is convenient for serving refreshments. A serving counter with a sliding or folding partition over it, forming part of the wall between the two rooms is popular for this purpose. This arrangement permits the efficient use of the kitchen for demonstration purposes in connection with cooking and canning classes, or in the use and care of kitchen equipment. The kitchen should always be large enough to be used as a separate room.



The counter between kitchen and club room is convenient for serving refreshments

> Never, never plan the kitchen as part of another room, especially of the community hall. — Virginia

If a child-care program is carried on in some of the community rooms, or if special rooms for a child-care center are attached to the community building, a separate kitchen to serve the children is strongly urged by tenants and directors of child-care programs who have had experience in sharing one kitchen.

The location of toilets directly adjoining rooms designed especially for use as health clinics, child-care centers or nursery schools, and planned for their exclusive use, is almost universally required by the agencies which operate these facilities.

The location of a sink in a room or in a nearby janitor's closet facilitates the use of the room for a craft program.

Built-in bulletin boards in the lobby, in children's playrooms and in craft rooms are useful for posting notices, exhibits and announcements of general interest.

The sizes and proportions of the rooms, the location of doors, the height and location of windows, radiators and other items of fixed equipment in all rooms, should be planned for a favorable arrangement of various kinds of furniture and equipment and also for adaptation to a variety of activities. Rooms with enough floor space for basket ball, for example, should be high enough and properly proportioned for the game.

Continuous low windows or a number of French doors along more than one wall of a room intended for general social use may prevent the efficient arrangement of furniture needed for informal social gatherings. Too many windows or low, unprotected light fixtures in a room large enough to be used for active games create obvious problems.

Durable and easily cleaned materials for walls and floors will reduce maintenance costs. Some managers recommend a wainscoting for the community hall, lobby, toilets, and most social rooms. Exposed concrete floors are not liked, except for craft rooms, toilets and tenant work shops. The use of rooms with exposed concrete floors for small children's programs is generally barred by agencies responsible for these programs. Linoleum is preferred for kitchens and children's playrooms, hardwood or asphalt tiles on concrete for practically all other rooms.

The construction of all community activity rooms should meet at least the fire-resistive requirements of the code recommended by the National Board of Fire Underwriters[1] or that of the American Standards Association,[2] as well as any building code which may be legally applicable.

Child-Service Centers

Space for child-service programs, if required, is normally provided in addition to the space required for other community-service programs. Rooms for this purpose are preferably planned either as a separate building or as a wing attached to the community building.

> If a child-care center is combined with other community rooms, it should be planned as a separate wing, so the children can be off by themselves. It seems to work better that way for everyone concerned.
> — Virginia

The joint use of community rooms for child-service programs and other community activities has generally proved unsatisfactory. In a number

A washable floor covering is needed where small children play

---

[1] Underwriters Laboratory. Chicago, current issue

[2] American Standards Association. New York, current issue

he child-service center needs space for low furniture . . . for meals . . .

of projects where rooms were not available for exclusive use for child-service programs, dwelling units frequently were converted for this purpose, and are preferred by some directors of child-care programs to buildings especially designed for their use.

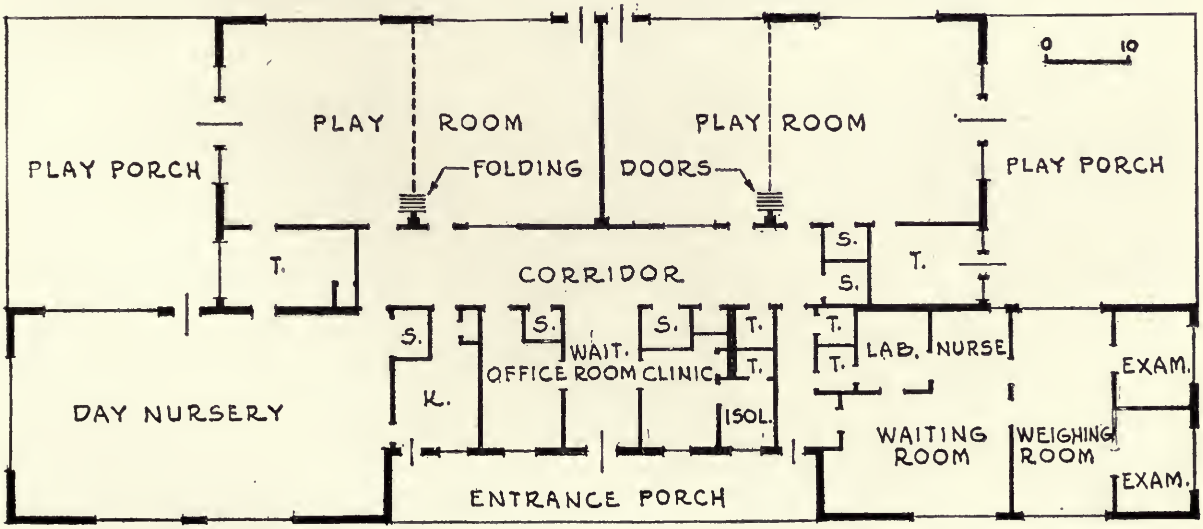
> We like the converted dwelling unit buildings better than those planned originally as child-service centers. They are much more "homey". — Virginia

The rooms required for a child-service center include:

1. One or more playrooms, depending on the number of children served. (A minimum area of 1,200 square feet for rooms used for play, meals and sleep is recommended by specialists for a center with an average attendance of 30 children).
2. Admission office, for inspection of children before they join the group.
3. Conference room (which may be combined with office in a small center).
4. Isolation room, for child requiring separation from the group for any reason.
5. Kitchen and laundry facilities.
6. Toilets for children and staff.
7. Storage spaces.
8. Lobby and corridors.
9. Waiting room (which may be combined with lobby).

A favorable orientation of playrooms to the sun and of kitchen and playrooms to the prevailing breeze are important considerations. The plan should provide direct entrance to office, playrooms

. . . and for craft work or games



A layout well designed to serve the various types of child-care programs

Children use cots for rest (above) and like a partly shaded terrace (below)

and kitchen from lobby or corridors leading from lobby, a convenient service entrance to the kitchen, and an emergency exit door from each playroom, for use in case of fire. Problems of supervision are reduced if toilets for children are located directly adjoining each playroom and close to the door to play yard. Staff toilets should be convenient to office and to kitchen. A special toilet, adjoining the isolation room, is recommended by child-care specialists.

A door between playroom and a fenced play yard is desirable. The door preferably should open on a paved terrace, part of which should be covered to provide shade on sunny days and shelter for outdoor play in wet weather. For recommendations on the design of play yards see "Outdoor Recreation" in "The Site Plan."

Some recreation directors want space indoors for climbing-structures, slides, and other large pieces of equipment. Others prefer to have all such equipment outdoors, although a shelter for some items is desired to permit use in rainy and snowy weather.

The kitchen should have ample storage space for staple supplies purchased in bulk and adequate refrigerator space for perishable supplies. A small laundry room equipped with a double tray and drying racks is desirable. Outdoor space for drying kitchen towels and children's garments should be accessible.

Locker space for children's clothes should be near a door leading to the play yard. Directors of child-care programs generally prefer to have such lockers movable rather than built-in. Space for storage of cots and blankets is essential for rooms used for sleeping. Low open shelves in each playroom are more convenient for the storage of most play materials than closets or shelves that cannot easily be reached by the children. Directors of child-service centers recommend, however, the provision of at least one closet that can be locked, for the safe storage of special supplies and equipment, such as paints, first-aid kits, and tools for occasional use.

The location of shelves, lockers, windows, and radiators should permit use of rooms for the varied activities of an all-day program, including block building, painting, stories, singing, dancing, games, playing house, carpentry work, eating, and sleeping.

Some windows should be low enough so that the children can look out. Some wall space should be kept free at two to four year old eye level for posting pictures of interest to children.

Low toilets and lavatories for the use of the children are more convenient than standard size fixtures.

A linoleum floor covering is recommended for all rooms. A washable finish is desirable for all walls and woodwork.

Blanket storage must be provided as well as lockers for outdoor wraps

Outdoor shelter for central laundry in a Southern project

Central Laundries

Central laundries are recommended only where adequate space and facilities for washing and drying the family laundry cannot be included in connection with the individual dwelling.

They have been provided in a number of projects composed of apartments and other types of dwellings which lacked private yards for drying clothes. They have also been provided in a few row-house projects, principally in localities where atmospheric conditions, such as excessive smoke and soot or frequent rainfall, make indoor drying necessary most of the year.

In some of the early low-rent developments, central laundries were provided primarily in order to keep laundry drying out of the public view, since it was considered that outdoor clothes-drying yards detracted from the appearance of a project. Another reason for central laundries was the planner's desire to take the laundry work out of the dwelling and to lighten the drudgery of the housewife by supplying for common use more efficient laundry equipment than could reasonably be provided for the individual dwelling. Some managers, however, who have had to meet the numerous problems involved in scheduling and supervising the use of central laundries, and in maintaining and repairing the equipment, tend to regard the central laundries at best as a necessary evil.

The attitude of the women for whose benefit central laundries were planned is mixed. They like "keeping the mess out of the kitchen" and where electric washing machines are supplied they welcome the release from much of the drudgery usually associated with washday. They are glad to have indoor drying facilities for use during wet weather. On the other hand they have rebelled almost universally against drying laundry indoors in good weather. Many of them learned also that although the laundering process might be simplified, other home-making problems were very much complicated by the use of central laundries.

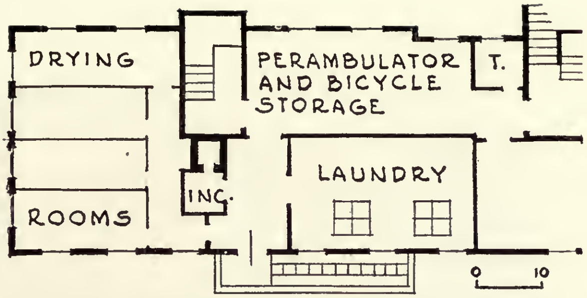
What to do with children is probably the most difficult problem. Those too small to go to school must go with their mother to the laundry, where they are a source of annoyance to mothers and managers alike. Children of school age are a problem during vacations; few healthy youngsters under twelve or fourteen years of age can be left unsupervised for several hours without hazard to themselves, damage to the dwelling, or irritation to the neighbors and to the management.

It is difficult, even for the orderly and efficient housewife, to meet the laundry schedule. Many women have to wash several times a week. This fact, and the unpredictable interruptions of the housekeeping routine which occur frequently, particularly in families with small children, make it very complicated for the most patient and conscientious management staff to work out a satisfactory laundry schedule.

Actually, of course, not all housewives are efficient and co-operative, nor are all managers patient and understanding, so that in some projects management-tenant conflicts have developed over the use of central laundries.

If given a choice, therefore, between fairly adequate space and facilities in their own homes and "the last word in mechanized equipment" in central laundries, few women would hesitate to choose the former. Central laundries are necessary, however, in some projects, and it is believed that some of the problems which have arisen in connection with their use in the past can be reduced, if not altogether eliminated, by careful design of the facilities.

Central laundries usually are located in the basements of dwelling buildings. Occasionally, however, they are placed in separate buildings or in a structure attached to the end of a row of houses. In a few Southern projects an outdoor shelter is used. The laundries are preferably so distributed that one is within convenient walking distance of every dwelling. Usually proximity to space for outdoor drying yards is desirable. In some projects no outdoor drying is permitted. In others, however, the washing is taken home from the laundry to be hung out in the tenants' private yards.

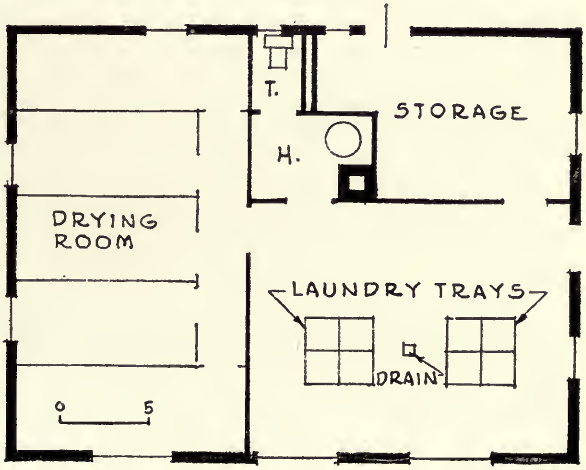


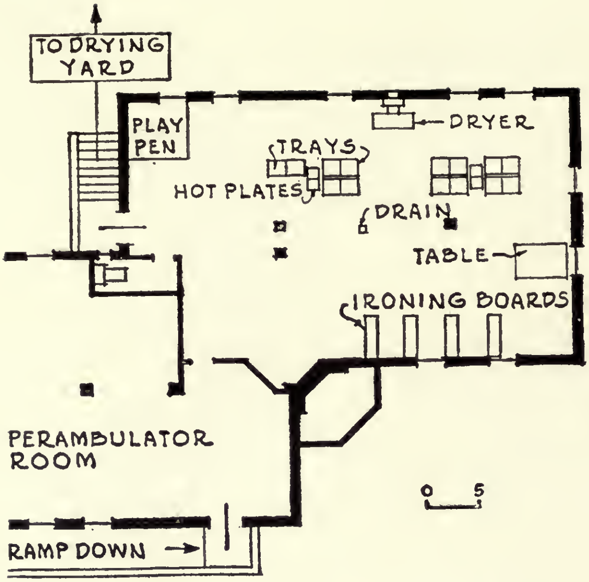
Typical apartment basement laundry with adjoining drying rooms

For a basement laundry which serves only families living in the building, an entrance directly from the stair well in which the laundry is located usually is preferred to an outside entrance. A separate outside entrance is required, however, for basement laundries used by families not living in the building. If an outside drying yard is provided, the door leading to the drying yard ordinarily serves also as the entrance to the laundry.

Basement laundries never should be planned for use as passageways from one part of a building to

A separate laundry building





Laundry with direct access to the outside drying yard

another. They should be planned so that they can be kept locked when not in use, otherwise they require constant supervision.

If the outside entrance is more than two or three steps below grade, a ramp approach is a convenience for women who must bring the baby in a carriage or who carry their laundry on a child's wagon. The ramp, however, should supplement low, broad steps since ramps are hazardous in wet and snowy weather.

Space required for central laundries varies according to the types of facilities provided and the number of families served. The usual equipment is: laundry trays, normally one pair for each ten or twelve families; ironing boards, which have been little used, however, since most women prefer to do their ironing at home; hot plates, also little used, and better included only where a survey of local laundry practices indicates that the women want them; electric washing machines, often furnished, metered and maintained by the manufacturing company; worktables or counters (frequently installed later, if not provided when the project is built).

Indoor drying facilities, consisting either of drying compartments or mechanical driers, have been installed, usually one to each pair of laundry trays; occasionally more. The number of linear feet of drying space provided varies considerably. No definite rule can be given as to the amount needed. It varies according to the efficiency of the equipment, and the amount of outside drying space available.

Storage space for tenant-owned washing machines is required where women use their own machines in central laundries; this space usually is along the wall of the laundry room or in an adjoining room. A pipe rail to which machines can be locked is often supplied as a precaution against the use of machines without permission of the owners.

Toilet facilities, either directly adjoining the laundry or reached by a connecting hallway, are essential.

If hot water and heat are not available from central systems, a hot-water heater is installed, and, where necessary, a heating unit.

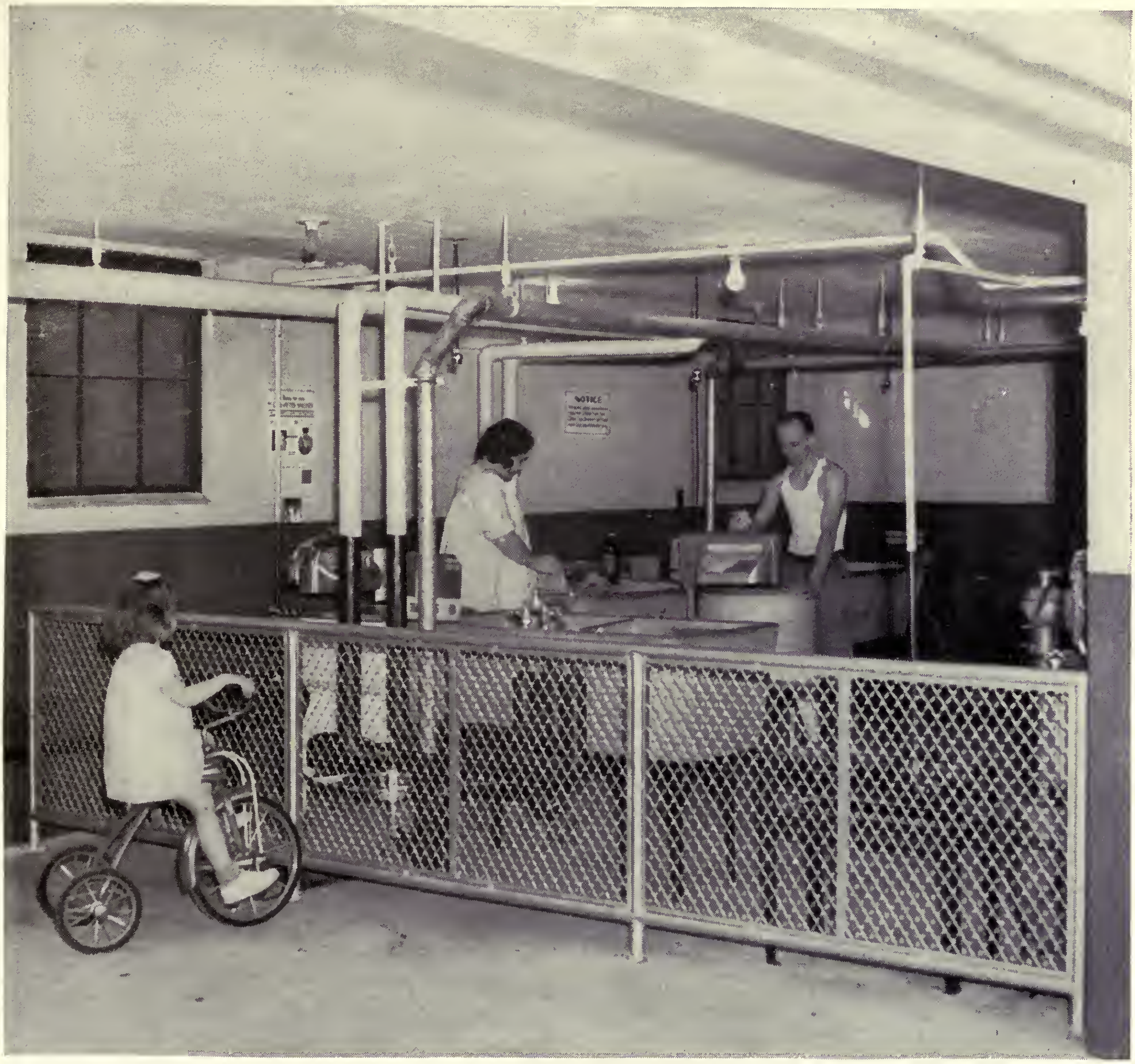
Good light and ventilation are essential to the satisfactory use of central laundries. As many work areas as possible should be arranged for good, natural light. Electric lights should be placed so that the light will fall directly on trays, work tables and other pieces of equipment.

If adequate cross-ventilation is not available, a ventilating fan is desirable.

The various items of fixed equipment should be so placed that ample space is available for the use of washing machines, as well as of the fixed equipment, and also to permit convenient circulation within the room.

Mechanical driers usually are placed in the same room in which the clothes are washed. Drying compartments (also mechanical driers, if they are not adequately insulated) are better in an adjoining room. The partition between the rooms should be of masonry or other insulating material. Danger of theft is reduced by the use of heavy wire mesh drying compartments, each equipped with a lock. Drying rooms should be, but are not always, supplied with special ventilating and drying apparatus. Such apparatus must be arranged to discharge air carrying moisture from the clothes to the exterior directly, since circulation of humid air through the apartment building or through the basement causes condensation and drip of water from windows which damages plaster and paint. Where ventilation is inadequate clothes have sometimes hung in drying rooms as long as three days without drying.

A small room, adjoining the laundry room, where young children can be left to sleep in their carriages



A low partition between laundry and play space adjoining laundry permits supervision and companionship

or to play while their mothers are busy in the laundry, is recommended by some managers. A play space formed by fencing off part of a large laundry room is better than none, provided the partition is high enough to "keep the little varmints out from under foot." A full partition is preferred, however, in order to keep the moisture of the laundry room from the children's room. Glass panels will permit supervision of children from the laundry.

A fenced play yard which can be reached directly from the play room is also recommended by some managers. Proximity to toilet facilities is desirable.

Difficulties have sometimes been caused for the management staff or tenants by these details:

1. In some laundries the floor drain is so placed that women working at the laundry trays or operating the machines must stand directly in the path of water flowing into the drain. Careful location of the drain will prevent wet feet, irritation and colds.
2. When basement laundries are located under dwellings, without effective insulation, a considerable amount of discomfort from sound or heat may be felt by first floor tenants.

3. Lack of a place to hang coats is a great inconvenience to the women using the laundry and contributes to an untidy appearance of the room.
4. Lack of facilities for hanging freshly ironed garments, if the laundry is used for ironing, makes difficulties.
5. Chairs or benches are often omitted in order to discourage the use of the laundry for social purposes. The lack of any place to sit down during a half day of heavy work, however, is a serious hardship for many women, and may have an adverse effect on health.
6. A location of electric outlets for washing machines which necessitates stepping over cords is hazardous.
7. Hot plates placed directly at the ends of laundry trays get wet and rusty. A location near the ends of the trays, far enough away to avoid splashing, is more satisfactory.
8. Lack of a shelf for washing powder and soap which can be reached easily from the laundry trays or washing machine is inconvenient.
9. Lack of individual lockers for personal laundry supplies (washboards, clothespins and so on) makes it necessary for women to carry such items to and from the laundry each week. Lockers might mean some additional management responsibility but would be convenient for tenants.

Hot plates should not be placed adjacent to trays

Yard Stations and Tenant Garden Tool Lockers

Yard stations are storage rooms for grounds maintenance tools, such as lawn mowers and garden hose, for the use of project gardeners and janitors. Stations are frequently about 80 square feet in area. They may be free-standing, attached to a building, or in a basement.

A toilet is sometimes included in the stations for the convenience of maintenance employees. In some projects, where a public telephone is otherwise unavailable, a public telephone booth is attached to the yard station.

In projects having tenant-maintained yards, a policy covering the provision and storage of garden tools needed by tenants should be worked out. In twin-house projects, where the need for garden tools will be greatest, storage space should be provided in each dwelling unit. In row-house projects a locker, say 15 square feet in area, is sometimes provided for each 12 to 20 dwelling units. No dwelling should be more than 250 feet from a tool locker.

These lockers should, when possible, be incorporated in the residential buildings, special attention being given to walk access, which should avoid encroachment on private yards.

Locker for tenant garden tools

Site Engineering

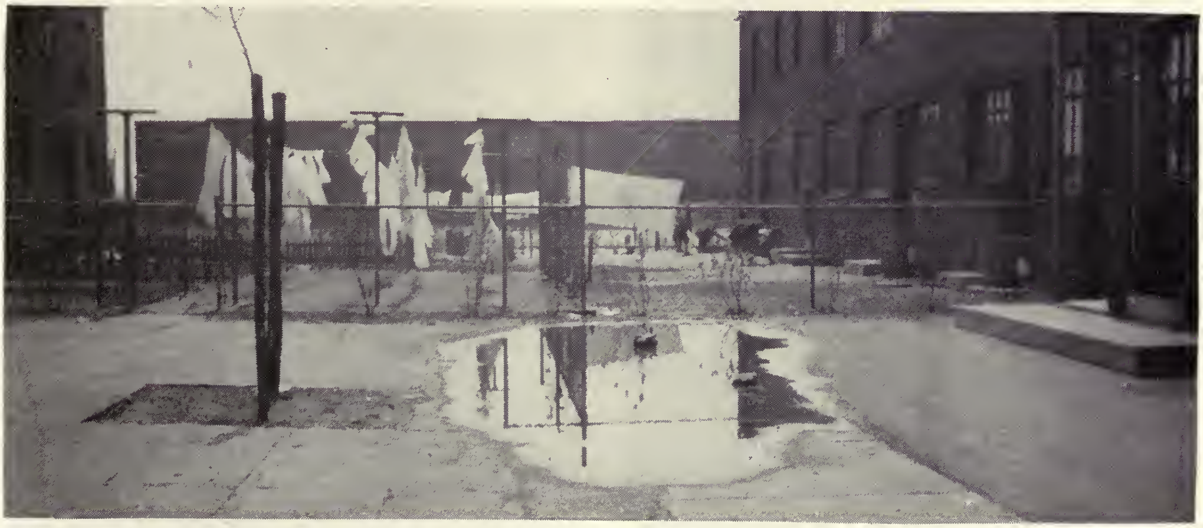
"SITE Engineering" is a term employed in public housing to describe engineering in connection with site improvements—water and gas distribution systems, sewerage, drainage, site grading, the construction of roads, parking areas, walks, play spaces, retaining walls, and similar work, apart from buildings. Except for the design of the electrical distribution system, as discussed in "Mechanical and Electrical Design", site engineering services are carried out normally by a civil engineer.

The design problems of the site engineer closely parallel those encountered in planning municipal improvements; but a special characteristic of site engineering for public housing is the fact that each improvement can be designed for known conditions which are subject to little or no change during the useful life of the improvement. No allowance need be made, as a rule, for population growth or for change in the physical characteristics of the area. Consequently, more precise design is possible than in planning municipal improvements.

The following text emphasizes certain features of design which, although not peculiar to housing in all cases, often have been found to receive insufficient attention, resulting in permanent defects in projects, or in the need for costly corrective work later. The necessity for thorough familiarity with approved site engineering practice and for painstaking, studied design cannot be overemphasized. The designer's objective should be the best possible balance between economy of construction, economy of project operation, pleasing appearance, and serviceability. As a rule, it will be necessary to lean toward low first cost, except when it can be demonstrated that annual costs (including debt service and operating costs) will be appreciably lowered, or that project livability will be improved materially, by greater initial expenditure.

Grading and Surface Drainage

Satisfactory grading design is dependent upon, but not assured by, a site plan carefully adapted to the topography. Although the site planner frequently bases early sketches on incomplete survey data, sufficient information should be available so that detailed grading studies may be made before the



Paving grades reflect inadequate design and supervision site plan is crystallized. From these studies first floor elevations of all buildings and controlling finished grades for open areas are established. Correlation of grading and site plans is essential, therefore, to assure the efficient use of open areas, satisfactory drainage, and pleasing appearance.

Bad grading results in serious drainage problems. Large center area regraded and drained to avoid flooding. — North Carolina

Drainage difficulties until corrections were made: tile drains, planting of banks, gravel, open ditches, and catch basins. — Washington State

Project grading plans are based on the following information:

1. The topographic map of the site.
2. Established grades for city streets bordering or traversing the site. If such grades are not established or if changes in them appear desirable action by the local officials should be requested.
3. Sewer elevations—existing and required.
4. Soil investigation data.
5. Information on grades and drainage conditions on adjoining properties.
6. Range of desirable height of first floor above ground; heights of crawl spaces and the proposed method of draining them.
7. Cross sections of proposed streets and service drives.

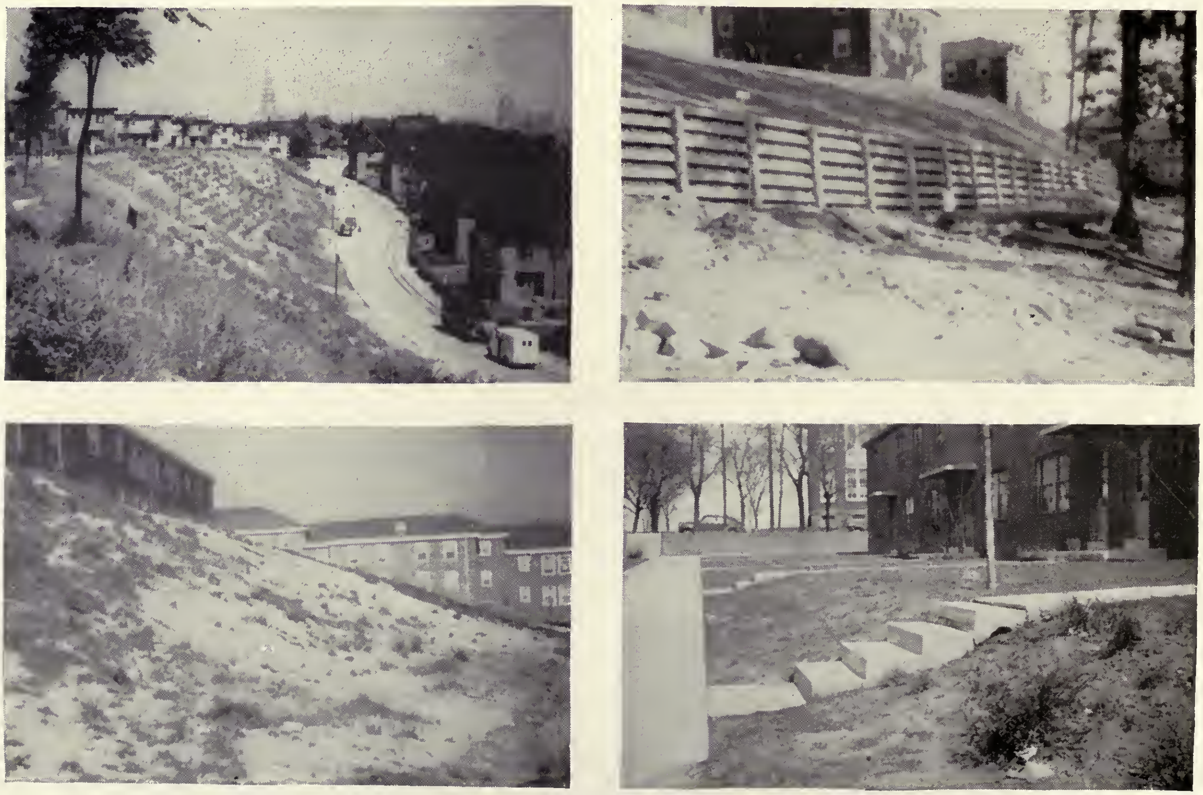
Project maintenance experience throughout the country shows that particular attention must be paid to problems of erosion, unstable hillside cuts and steep earth banks.

Erosion on sloping banks: Preservation of grass on slopes of any steepness practically impossible. — New York

Erosion due to sandy soil, absence of ground cover and combination of crowned roadways which take surface drainage and no paved gutters to take care of drainage adequately. (Need for review of plans by site engineer.) — Research Association Report

In working out the general grading scheme a reasonable balance of cut and fill makes for economy. Where rock or water-bearing sand is encountered near the surface, however, considerable fill may reduce the costs of utility trenching. Fill usually simplifies surface drainage design and reduces the amount of storm sewers needed.

Topsoil is best conserved when finished grades are held to the original surface or to levels a few inches above it.



Steep banks present difficult design and maintenance problems

The following table gives desirable limits for slopes on different types of areas. Deviations may be warranted by especially favorable conditions, such as porous soils, mild climates, or light rainfall; also if local experience indicates that other gradients are satisfactory.

TABLE I
DESIRABLE SLOPES

	Percent Slope	
	Maximum	*Minimum*
Streets, service drives and parking areas	8.00	[1]0.50
Collector and approach walks	[2]10.00	0.50
Entrance walks	[3]4.00	1.00
Ramps	15.00	.....
Paved play and sitting areas	2.00	0.50
Paved laundry yards	5.00	0.50
Paved gutters	......	0.50
Project lawn areas	[4]25.00	1.00
Tenant yards	10.00	1.00
Grassed playgrounds	4.00	0.50
Swales	[5]10.00	[6]1.00
Grassed banks	4 to 1 slope	
Planted banks	2 to 1 slope (3 to 1 preferable)	

[1] 0.75% for dished section.

[2] Less where icy conditions may occur frequently.

[3] Slopes up to 10% or more are satisfactory provided walks are long enough to employ a curved profile, so that a slope not exceeding 4% can be used adjoining the building platform. See also preceding note.

[4] Steepest grade recommended for power mower.

[5] Less for drainage areas of more than approximately ½ acre.

[6] 2.00% preferable in all cases, particularly so where swales cross walks.

Failure to provide positive pitch away from buildings and to give open areas adequate slopes has necessitated costly regrading and reconstruction work on numerous projects. The trouble has been due in part to inaccurate construction, but incomplete or poorly conceived plans have been a contributing cause.

Of two basic design methods, one provides for drainage mainly across grassed areas, generally through "swales", until the water reaches streets, drives, or storm sewer inlets. This scheme, requiring the flow of water from walks onto lawns, is not altogether effective when slopes are inadequate and finished grading is not accurately executed, or if the turf is above the walk level. Swale drainage occasionally is carried under walks by small culverts (six- to eight-inch pipes or boxes). These are slight hazards and frequently become stopped. The other method employs walks to a considerable extent as drainage channels. This scheme has met some objection; nevertheless, it generally is more economical and practical than the use of swales, and it has been used far more widely. Moreover, when walks have been given proper cross and longitudinal slopes, with sewer inlets provided at points of concentrated storm water flow, there has been no serious inconvenience to tenants.

Swale drainage along a walk

Swale drainage carried under a walk

Walks are used as drainage channels if topography permits

Site topography, however, seldom permits the use of the latter method exclusively; swales usually are necessary or desirable in some locations. Swales are employed to conduct surface drainage around buildings and through yards, to collect surface water from large areas, to intercept drainage at top and bottom of banks, to parallel walks and intercept drainage before it reaches them, and to carry off drainage from downspouts. Preferably, swales should be sodded except where they drain small areas or have very moderate grades.

Since storm sewerage systems are practically never built to handle maximum storm flows, grades should be worked out to minimize flood damage. The most positive protection is obtained when streets and service drives are located in natural drainage courses. Excess flow will escape to the streets and drives, creating little damage even though they are flooded temporarily.

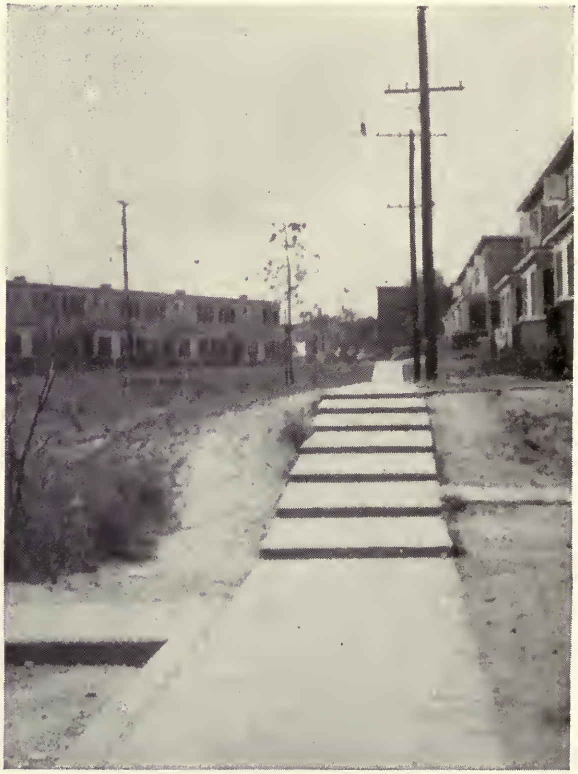
The development of a vacant or partially vacant site often greatly increases storm water runoff. It is not desirable (often not allowable) to increase the runoff to private property.

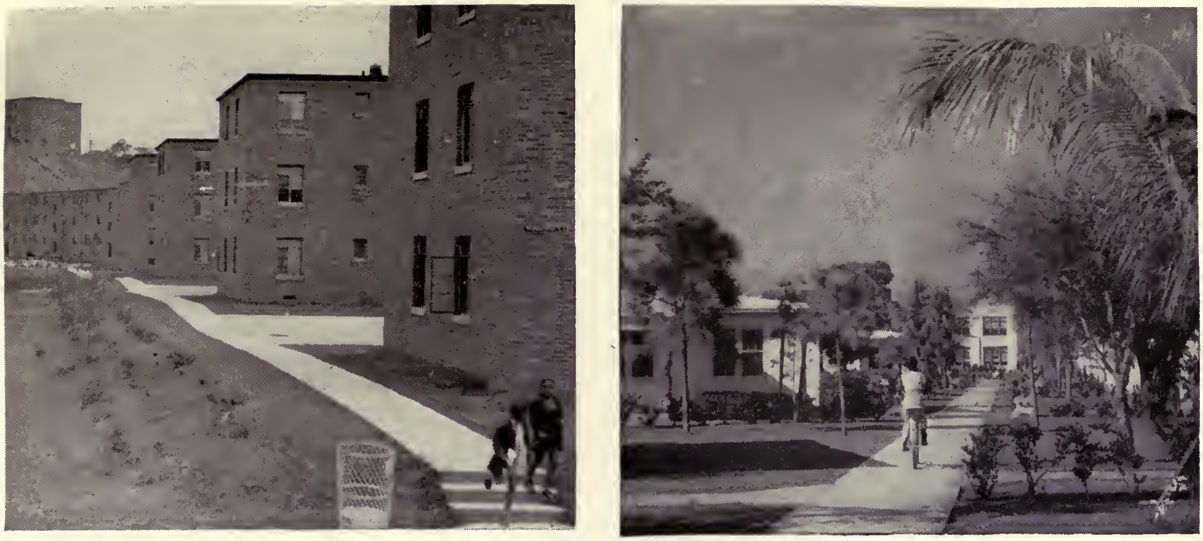
Housing management authorities strongly condemn the use of steep banks, largely because of difficult maintenance problems. Furthermore, the steps which steep banks may necessitate in walks are both a nuisance and a hazard.

Bicycles and baby carriages can be handled over stepped ramps (perrons) with less difficulty than over ordinary steps. Perrons can be dimensioned to correspond to slopes from 6 to 1 up to 4 to 1—that is, slopes on which power motors can be operated. When perron treads are long the over-all gradient is likely to be that to which a normal ramp (far more satisfactory) can be adapted.

Stepping stones have been used on slopes up to 4 or 5 to 1 and have proved satisfactory for entrance walks. They require more maintenance, however, than stepped ramps.

The public has made ramps beside the perrons





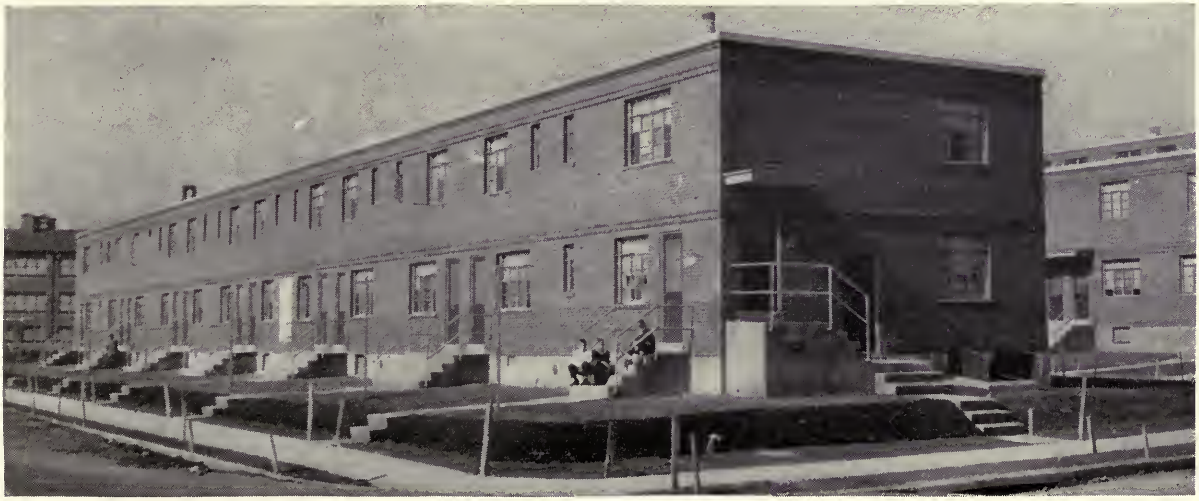
Wavy profile contrasts unfavorably with walkway laid to uniform slope

Grading design on steep sites is aided by conforming the proposed grades to the existing slope of the site rather than by making a series of benches. Entrance walks can be laid with fairly steep slopes and sloping grades used along buildings, with steps placed at building entrances where necessary. The slopes give good drainage on the upper side of long buildings and diminish differences between first floor elevations at building ends.

The preferred first floor elevation of buildings in relation to adjacent streets and drives is one that allows entrance walks to slope away from buildings evenly, and without steps, at gradients of from 1 to 4 percent. When buildings must be set too low to permit this, swales are introduced or drain inlets provided. When buildings must be set too high, yards are too often given gentle slopes terminating in sharp banks and necessitating steps in the entrance walks. This gives usable yards having a pleasing appearance but possessing the disadvantages always inherent in steep banks and steps; comparatively steep entrance walks, when they can be used, are preferable. See "The Ground Surface" in "The Site Plan."

Lack of adequate drainage in crawl spaces has required costly correction on many projects. Al-

Yards have pleasing appearance but disadvantages always inherent in sharp banks



though the design of these spaces is an architectural responsibility, drainage of them is closely related to project grades.

Pavements and Other Surfaced Areas

The location of streets, service drives, parking spaces, walks, laundry yards, recreation and other hard-surfaced areas is fixed by the site plan. The detailed design of these areas requires, in addition to special experience and judgment on the part of the site engineer, a full knowledge of soil, drainage and climatic conditions, and of the character and cost of locally available materials. Unfortunately, however, the design of pavements and other hard-surfaced areas for low-rent projects frequently has been based on an offhand selection of surfacing types and an unstudied fixing of thicknesses.

The subsurface investigations of the site are intended, in part, to supply information useful in the design of pavements and other hard-surfaced areas. Such information should be supplemented by field investigation by the designing engineer, who must possess all the facts necessary to determine (1) the possible need for subdrainage of proposed pavements or other hard-surfaced areas, and (2) the advisability of subgrade stabilization as a means of economizing in the thickness of pavements and insuring their stability.

As a rule, it is in the interest of low cost and good workmanship to specify city or state standard pavement types, since these usually permit the use of locally produced materials, and are types which local contracting organizations are equipped to lay.

The type of pavement or other hard surface selected for use and the design details are affected by:

1. Cost—both capital and maintenance: Projects of high density usually warrant a more costly type of pavement than do projects of low density.
2. Soil and climatic conditions: On heavy clay, particularly in localities having severe winters, a rigid pavement, concrete, is generally the most suitable.
3. Local materials and local construction practice.
4. Scheme of storm-water drainage.
5. Possible use of roadways for project construction purposes: This sometimes occurs in the case of vacant sites on which soil conditions are unfavorable, and when construction will be carried on during the winter.

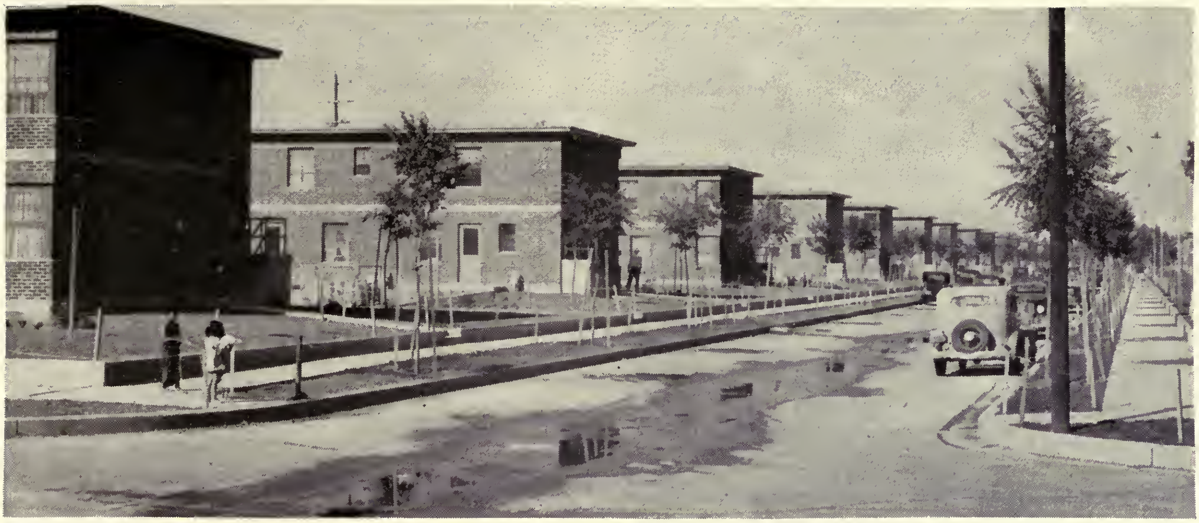
PAVING MATERIALS

Concrete pavement has been widely used for streets and service drives because of its durability, reasonable first cost, and low maintenance cost. Surface courses, as sheet asphalt or brick over a concrete base, are usually too expensive for use in low-rent projects.

Bituminous pavement is used because of its low cost (under favorable conditions), ease of repair, flexibility—particularly for laying over new fills—and pleasing appearance. Bituminous pavement, however, usually has cost more to maintain than concrete. In the majority of cases this has been the result merely of using a relatively inexpensive and non-durable type of surfacing, although in some instances it has been due not to defects inherent in the type but to faults in design or construction—particularly to lack of underdrainage or effective surface drainage, unwarranted reduction of pavement thickness, and inadequate inspection.

The cost of a bituminous pavement, consisting of a good plant-mix surface course laid over a substantial macadam or black base, and provided with concrete curb and gutters, usually will approximate that of a concrete pavement. Where an existing base can be used the cost of bituminous surfacing is much less than that of concrete; in any case, if low cost is imperative, it can be attained by using a less durable type of bituminous surfacing. Still cheaper surfacings, such as waterbound macadam and gravel without a bituminous wearing course, are generally unsuitable for project streets and service drives. Such surfacings may be satisfactory, however, in small projects where they are used and favored in the surrounding community.

> There has been trouble with macadam and bituminous surfaces. Many contractors do not possess the "know-how." No trouble with concrete. — Regional Report
>
> Concrete is more satisfactory than clay, gravel or cinders, oiled. These have proven very expensive in maintenance, as they break down under the traffic they must carry, and require constant attention. — Regional Report
>
> Gravel roads should be asphalt-treated for proper maintenance. First rain washed gravel so badly concrete curb and gutter are in danger of destruction for lack of base. — Texas
>
> Roads (and walks) constructed of loose, unprepared grading and unrolled limestone chats wash badly during rain, and require constant repair and maintenance. — Texas



The dished section is undesirable for streets and main drives

DESIGN OF STREETS AND SERVICE DRIVES

The crowned section with curbs is the most commonly used for both street and service drives and, except for minor service drives, is the most desirable. The only objection to its use is cost. In some projects curbs have been omitted from crowned sections, with a resultant saving in first cost but with considerable additional expense for the maintenance of shoulders, side ditches and edges of the surfacing.

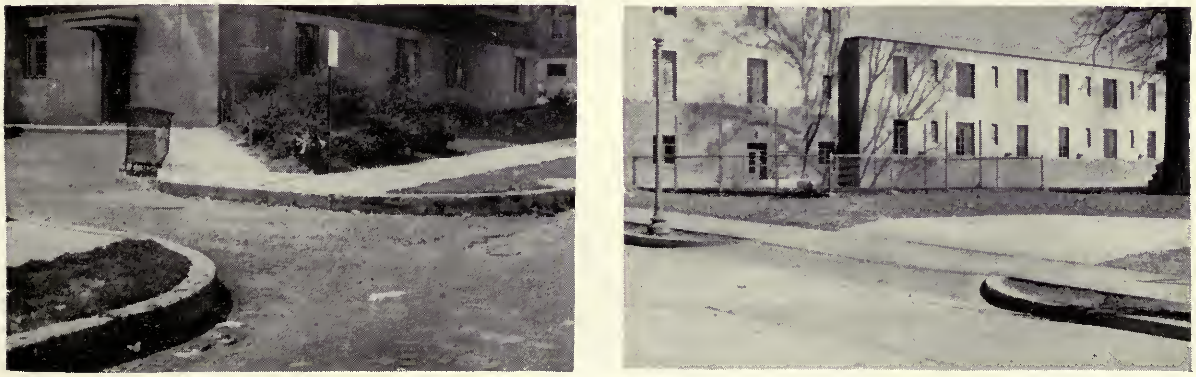
> No road paving should be built without edge, i.e., curb or gutter and curb. — Virginia

> All vehicular circulation should be paved with a hard-surfaced material with curbing to prevent traffic from encroaching on adjacent lawn areas. Do not use earth shoulders between road paving and curbs. — Regional Report

> Lack of curbs suitable because of sandy nature of soil. — Florida

The dished section has been used on many projects. It is the most economical with regard to storm sewers, since storm water is collected in the center of the pavement, instead of on both sides. Futhermore, curbing is less essential with this section, although curbing usually is worth its cost, and service drives can cross walks at the walk grade. Dished pavements, however, are not liked on some projects where they have been laid. Unless slopes are adequate and the pavement is accurately graded, pools form in shallow depressions and during freezing weather the center of the pavement is likely to remain icy. The dished section is not recommended for other than service drives or with paving material other than concrete.

> Recommended that no catch basins be placed in the center of any roads, but that all catch basins and drainage should take place at the sides. — Regional Report



Service drives, cutting sidewalk grade (left) and crossing walk at grade (right)

The inclined plane section, with curbs at different elevations and drainage at the lower side, has been used in some instances to fit driveways to topography and to reduce storm sewer costs.

Grades are controlled largely by the slope of the site and by street gradients used locally. A 0.50 percent grade is the commonly employed minimum. Where a combination curb and gutter is used (permitting accurate finishing) it should be safe to use a slope as low as 0.30 percent; a grade of at least 0.75 percent is desirable for pavements of dished cross section.

Reports from housing projects in operation have emphasized the need for curbs for the protection of lawns, planting and other improvements along project streets and service drives. For concrete pavement, either with crowned or dished section, an integral curb serves the purpose of a "thickened edge" and so adds little to the pavement cost. For bituminous pavement, concrete curbs provide permanent protection to the pavement edge. A combination curb and gutter is preferred to a plain curb: Not only is concrete a better material for the gutter, but there is less tendency for the concrete to draw away from the bituminous pavement and permit water to reach the subgrade.

The construction of curb and gutter to true line and grade before any type of pavement is laid simplifies the laying of a well-graded and smooth riding surface.

DESIGN OF PARKING AREAS

In general, the design of surfacing for parking areas is similar to that for streets and service drives. Except where parking areas are to serve as access to garbage collection platforms or for fuel delivery, wheel loading will be lighter and surfacing thickness may be less than for streets.

As a rule bituminous surfacing is preferred to concrete for parking areas because of its lower cost and more satisfactory appearance. Concrete for parking areas usually is limited to small bays adjoining concrete roadways. Plans for such areas should include layouts of expansion and contraction joints.

There have been a few reports of disintegration in bituminous surfacing on parking areas caused by oil drippings and gas leaks. Tar mixtures are a remedy.

Recommendations based on project operating experience stress the need for curbs around parking

Concrete markers found necessary for protection of lawns

areas. Wood bumpers of several kinds have been employed as substitutes, but they are by no means so satisfactory as concrete curbs.

> Parking is not confined to assigned space because there are no barriers or curbs. — New York

> Lack of parking lot bumpers (and lack of binder) results in parking on lawns and spreading of gravel. — Ohio

DESIGN OF WALKS

Concrete has been found to be by far the most satisfactory surfacing material for walks of low-rent projects. Its advantages include:

1. A surface satisfactory in almost all respects.
2. Low maintenance cost.

> Concrete has proved to be the only satisfactory material for sidewalks for both front and rear of dwellings. Walks made of asphalt, gravel or stone are decidedly unsatisfactory and expensive to maintain. In some projects where crushed stone and gravel has been used it has had to be replaced every six months. — Pennsylvania

> Concrete or asphalt walks both convenient and attractive. — Washington State

> Concrete walks satisfactory but most unattractive. — Washington State

Stepping stones frequently are used for house entrance walks and minor circulating walks, and usually result in a slight saving in first cost. They sometimes are laid in a stepped fashion in the place of concrete steps. Stepping stones, however, are difficult to set and keep at finished grade, and to mow around, and are less satisfactory than concrete walks for baby carriages and wheel toys.

> Stepping stones for paths, poor unless other provision is made for children's wheel toys. If no provision is made for these, nothing will keep kids off the street. — Virginia

> Stepping stones better than clay or gravel walks, from which dirt is tracked into houses, and which don't retain their outlines. — Connecticut

Concrete slabs or flagstones laid closely cost in most instances at least as much as concrete walks, and are not so satisfactory.

Stepping stones laid on a slope

Walks with bituminous wearing surfaces are of pleasing appearance; they sometimes can be laid at slightly less cost than concrete walks. Conditions favorable to the use of bituminous walks are (1) wide walks, free from angles, steep grades, steps and other obstructions, (2) a mild climate, and (3) a firm, stable soil. Such favorable conditions rarely happen in combination, however, and any possible advantages of bituminous walks are generally outweighed by (1) the difficulty of obtaining good compaction of the base and surface courses, (2) the risk of inferior workmanship unless expert inspection is provided, (3) the considerable cost of steel or concrete curbing set flush with the surface, which is necessary if the walks are to be comparable in wearing quality with concrete, and (4) higher maintenance costs. Bituminous walks should have a smooth, dense surface.

> Asphalt and bituminous sidewalks are unsatisfactory: They develop potholes and sags and collect water. — Regional Report

Experience with gravel walks in public housing projects has been wholly unsatisfactory. The binder tracks into houses and the gravel is thrown around by children.

WALKWAY EDGING

In some comparatively high-density projects edging or low curbing along walks has been necessary to prevent destructive wear on adjoining areas. In many projects it has been impossible to maintain grass in narrow strips between sidewalks and curbs or buildings. Consequently such areas have had to be surfaced after project occupancy.

Old paving blocks have been available in some large eastern cities and have proved excellent for surfacing narrow spaces. Bituminous material, brick, precast concrete slabs, and flagstones also have been used. The last three materials are pleasing in appearance but are likely to be pulled up or become dislodged, and may cost more than if concrete were extended to the curb.

> Grass between sidewalks and streets became worn. Has been paved with black top, which is unsightly. — New York
>
> All narrow open dirt or shrub spaces between sidewalk and buildings should be paved with Belgian block or cement. However, ivy beds may be used. — Regional Report
>
> Outer edge of sidewalk 1′-6″ from curb, leaving a narrow strip which cannot be planted and maintained satisfactorily. Recommended: That sidewalk abut curb or else be at least 4′ from it so space can be planted. — Pennsylvania
>
> Space between walks and curbing should not be grassed. — Connecticut

Narrow grass strips are hard to maintain

An edging helps to prevent wear

SURFACING FOR COMMON LAUNDRY DRYING YARDS

Bituminous pavement of some kind most frequently is used as a surfacing for common laundry yards, and has generally been considered satisfactory. Managers of projects in which grass is used in common drying yards report that any type of hard surfacing is preferable to grass or earth.

> Laundry yards should be surfaced with cinders or gravel, or else have duckwalks. — New York
>
> Graveled surface is an absolute necessity in laundry yards in regions where there is adobe mud. — California

SURFACING FOR RECREATION AREAS

Recreation areas require various types of surfacing, depending in part on the type and size of the areas, but also to some extent on the kind of soil and adequacy of drainage of the area. Climate also must be considered.

Reports from managers and others concerned with public housing projects show a wide difference of opinion, however, as to types of surfacing which should be provided.

> Sod is the most satisfactory surface for playgrounds in this region. — Regional Report
>
> Grassed areas look unsightly, should have a more durable surface. — Florida
>
> Both paved and grass play areas should be provided. Clay areas are difficult and expensive to maintain because of children digging in them. If special places are provided for digging, this may be less of a problem. — Regional Report

Sand-clay surface unsatisfactory — should be paved. — Georgia

Provide earth digging-areas in small playgrounds. — New York

Cinders for play area bad. — Pennsylvania

In confined areas, such as entrance courts to apartment buildings, provide paving throughout, with tree pockets and shrub planting adjacent to building walls only. Avoid the use of small lawns and freestanding planting areas. Small digging-areas for children may be incorporated provided they are surrounded by a paved area and do not encroach upon lines of circulation. — Regional Report

Paved areas are needed for wheel toy play. — Regional Report

Kids will use wheel toys on paved areas; where not enough is provided for their use they go into streets. — Virginia

Types of surfacing most commonly reported as satisfactory for various types of recreation areas in relation to density are listed in Table II. The list is by no means complete. It is not practicable, for example, to list separately the many kinds of bituminous surfacing used in low-rent developments.

The advantages and disadvantages of the types listed in Table II are summarized briefly in Table III, together with comments on several other types which have been used less frequently.

TABLE II

RECOMMENDED SURFACINGS FOR RECREATION AREAS, RELATED TO PROJECT DENSITY

Kind of Area	*Low and moderate density projects* (*Singles, twins, row houses, and flats*)	*High density projects* (*apartments*)
General recreation area[1]	Turf, natural soil	Bituminous concrete and sand-clay, natural soil.
Special play areas:[2]		
Water play	See "Spray Pools" in text	See "Spray Pools."
Child service play yards	80% turf, 20% concrete	80% turf, 20% concrete.
Game courts	Bituminous concrete, portland cement concrete, sand-clay, turf.	Bituminous concrete, portland cement concrete, sand-clay, cork asphalt.
Under playground apparatus	Lightloam, sand, tanbark, sawdust, shavings, turf.	Light loam, sand, tanbark, sawdust, shavings.
Crafts and story-telling	Any hard surfacing or turf	Any hard surfacing or turf.
Outdoor parties, dances, roller-skating, etc.	Any smooth, hard surfacing	Any smooth, hard surfacing.
Local play areas:		
For small children	Principally turf or natural earth, and smooth hard paving.	Principally a smooth hard paving and some turf or natural earth.
For all age groups	Turf, bituminous concrete, portland cement concrete.	Bituminous concrete, cork asphalt, portland cement concrete.
Sitting areas	Bituminous concrete, portland cement concrete, brick, precast concrete slabs, flagstones.	

---

[1] Includes general recreation area which is part of principal recreation area, also secondary general recreation areas. See "The Site Plan."

[2] Surfacing recommendations apply both to special play areas which are part of principal recreation area and also to secondary special play areas. See "The Site Plan."

TABLE III

ADVANTAGES AND DISADVANTAGES OF VARIOUS SURFACINGS FOR RECREATION AREAS

Surfacing Type	*Advantages*	*Disadvantages*
Turf	Soft surface, ideal for many play purposes. Low first cost.	Cannot be used in wet weather. Difficult to maintain.
Natural soil	Low first cost. Soft surface	Muddy in wet weather, dusty in dry weather.
Gravel	Low first cost. Pleasing appearance	Children throw it about to such extent that it is unsuitable for any use as surfacing in housing developments.
Sand-clay and clay-gravel	Low cost when suitable material available. Reasonably soft surface.	Difficult to get properly proportioned mixture.
Brick (on sand cushion)	Attractive appearance	Initial cost relatively high.
Stone paving blocks (on sand cushion or natural soil).	Low cost when salvaged from old pavements. Satisfactory appearance. Durability.	Surface too rough for play use. Maintenance cost relatively high.
Precast concrete slabs (on sand or natural soil).	Year-round utility. Satisfactory appearance.	
Flagstones (on sand or natural soil).	Year-round utility. Pleasing appearance. Durability.	
Bituminous concrete (See following text).	Good surface for most play purposes when properly specified and laid. Not so hard on feet as portland cement concrete. Year round utility.	Rough and abrasive unless properly specified and constructed. (Competent inspection essential for good workmanship.) Hot for bare feet. May become soft. Unattractive in large areas.
Cork asphalt (See following text).	Resiliency. Excellent surface for many play purchases. Year-round utility. Satisfactory appearance.	Comparatively high cost. (Competent inspection essential to good workmanship). Softens in very hot weather.
Portland cement concrete	Year-round utility. Minimum maintenance expense. Good surface for wheel toys, roller skating and and some court games.	Lacks resiliency. Initial cost relatively high. Large areas require expansion joints. Whiteness and glare of large areas unattractive.

The comparatively low cost of maintaining bituminous surfacing, plus the fact that it is often the least expensive type of hard surfacing to install, has led to a wide use of this material in low-rent projects. Not all types of bituminous surfacing used, however, have proved satisfactory, and construction has sometimes been faulty. A hard-surfaced area for play should be smooth, dense, fine-grained, and impervious.

Cold-laid asphaltic concrete, as customarily laid, is too coarse to be entirely satisfactory for play area surfacing. Sheet asphalt surface course and hot-laid asphaltic concrete have a much better texture for the purpose. The base course should be heavy enough to provide an unyielding foundation for the wearing course. The thickness of the base in each case is governed by soil and climatic conditions.

Permanent side supports are desirable for bituminous surfacing unless it is laid against walks or other similar construction. Concrete, brick or steel curbing set flush with the surfaces is recommended.

> All areas paved with bituminous material should be enclosed with flush-type permanent edging to prevent ravelling. — Regional Report

Wooden side forms have proved unsatisfactory as a rule, since they are heaved by frost; they should be used, therefore, only when initial cost limitations make it necessary.

Bituminous surfacing can be laid satisfactorily only by means of a power roller. For this reason it is not adapted to very small or irregularly shaped areas, unless these are located in places where a roller can be used.

Cork-asphalt surfacing has been highly recommended by some playground specialists because of its resiliency. Both hot-mix and surface-treatment types have been laid in a number of projects. Specimen areas of the two types and of different mixtures were laid on a large play area for special observation. While this test hardly warrants drawing definite conclusions, the hot-mix cork asphalt in this instance gives a durable surface, slightly superior for play purposes to other bituminous surfacings and shows no sign of deterioration after four years of use.

The following tentative recommendation for northern areas is based on this test.

HOT-MIX CORK-ASPHALT SURFACING

Ingredient	*Percentage by weight*
Ground cork, 8- to 24-mesh	5½
Sand, graded as for sheet asphalt	71
Limestone dust	7½
Asphalt, 70 to 85 penetration	16
	100

Turf is ideal for many play purposes

Tenants often build low picket fences, useful as boundaries and for plant backgrounds

Miscellaneous Site Improvements

FENCES

The type and height of fences provided depend on the purposes for which they are to be used. Fences formed of strands of wire strung on low posts should be avoided. Such fences are so inconspicuous that tenants frequently trip over them, and they also create a hazard when the wires are broken. Low picket fences have been found satisfactory in a number of localities for enclosing tenant yards. Often picket fences are constructed by tenants. The height commonly used is thirty inches.

> Philadelphia has been very successful with the use of picket fences around individual tenant areas. All such fences are of a more or less uniform design, made of wood, about twenty inches high, for the most part painted white; either they are made by the tenants themselves or by the maintenance division and sold to the tenants at a nominal cost (6-foot lengths at 65¢). This gives the tenants a financial interest in their lawns and has proved to be very successful in aiding maintenance. — Regional Report

Wood fences 3 feet 6 inches in height have been used to enclose children's play areas in a number of projects. Reports indicate that this type of fence is satisfactory only in projects of low density, where adequate recreational facilities are available for older children. In projects of high density, or where recreational facilities for older children are limited, wood fences afford insufficient protection, and are damaged by older children climbing on them.

> Nursery school playgrounds should be enclosed with 6-foot high chain-link fences. — New York

> Chain link fencing is the most satisfactory type for all play areas. It should be about four feet high around play yards for small children. — Washington State

Chain-link fences of varying heights are recommended for many purposes. The heights of chain-link fencing usually considered satisfactory for various types of areas are listed in Table IV, following.

TABLE IV

HEIGHT OF CHAIN-LINK FENCING

Area	*Height*
Individual yards	3′ – 3½′
Common laundry yards	4′ – 5′
Rubbish collection stations	height of cans
General play area	5′ – 6′
Local play areas for preschool children	3′ – 4′
Child service play yard	3½′ – 4′
Along project property lines, parking areas or railroad right-of-way bordering project for protection against hazards and trespassing	5′ – 8′

Fencing four or five feet high, recommended for common laundry yards, affords sufficient visual protection if the fence is used for support of vines without interfering with free circulation of air. A higher fence may be required on one or more sides if used to screen the yard from a public street.

Higher fences may also be required around general play areas or child-service play yards to meet special local conditions.

Where temporary fencing is necessary, the specifications should require fencing of good appearance.

Large amount of chain link fencing well liked — protects shrubs, defines areas, is inconspicuous and requires little maintenance. When it surrounds a yard infants can be turned loose. Often forms a background to exuberant planting.—California

Other types of fences which have proved useful for special purposes include:

1. Board fences, used for screening common drying yards and play areas on one or more sides, particularly in localities where protection from strong winds is desired; also for enclosing or screening rubbish collection stations.
2. Masonry walls, sometimes used to enclose small children's play area where protection from raw winds is needed; also used to enclose or screen rubbish collection stations.

Temporary fences are usually needed for the protection of newly planted lawns and shrubbery. If they are to be provided by the contractor it should be stipulated that fencing be erected which will be pleasing in appearance and easy to maintain after the project is occupied.

CLOTHESLINE SUPPORTS

A detailed discussion of the arrangement of clothes drying facilities is in "The Site Plan". Clothesline posts are made of steel pipe, steel rolled section or wood. Steel pipe has the advantage of equal strength in all directions; while not so stiff as the special "H" or "I" sections used by fence manufacturers, it is much stiffer than steel angles and tees. The latter sections are not economical for use as posts. Wood posts as a rule cost slightly less than steel. They have been satisfactory although not often used in permanent projects.

To avoid either flimsy or excessively heavy sections for clothesline supports some reasonable assumption must be made regarding a "design loading." Such a loading, translated into requisite post sizes for standard steel pipe, is given below:

TABLE V

STANDARD STEEL PIPE DIAMETERS FOR CLOTHESLINE POSTS

Number of Lines	*Average length of lines*			
	20 feet	*25 feet*	*30 feet*	*35 feet*
	Inches	*Inches*	*Inches*	*Inches*
1	1½	2	2	2½
2	1½	2	2½	2½
3	2	2	2½	2½
4	2	2½	2½	3
5	2	2½	2½	3

The pipe sizes noted make allowance for the strain posts will receive if children swing on the lines.

Children swing on clothesline posts

The dome-type spray head is thought to be better than the bath-shower type

SPRAY POOLS

Spray pools in housing projects present a wide variety in design—in form, size, and spray apparatus. In general it may be said that the pools as built have proved fairly satisfactory, although field investigations are not sufficiently advanced to permit drawing definite conclusions on certain points.

Generally speaking, circular or oval pools are best fitted to the spray from "dome-type" heads, and rectangular pools to that from rows of small nozzles. The required size of the pool is affected somewhat by climate, but for checking purposes an area of 200 square feet may be assumed for each 100 dwellings, with minimum areas of 400 square feet and 700 square feet, respectively, for nozzle- and dome-type spray heads. These areas refer to the pool proper. A surrounding pavement at least eight feet wide has been found to be essential. Concrete, amply reinforced and without joints, has proved to be the best material for the spray area. The surrounding pavement also should be impervious—either bituminous or portland cement concrete. Curbs are tripping hazards and make the pool area less suitable for out-of-season roller skating and games.

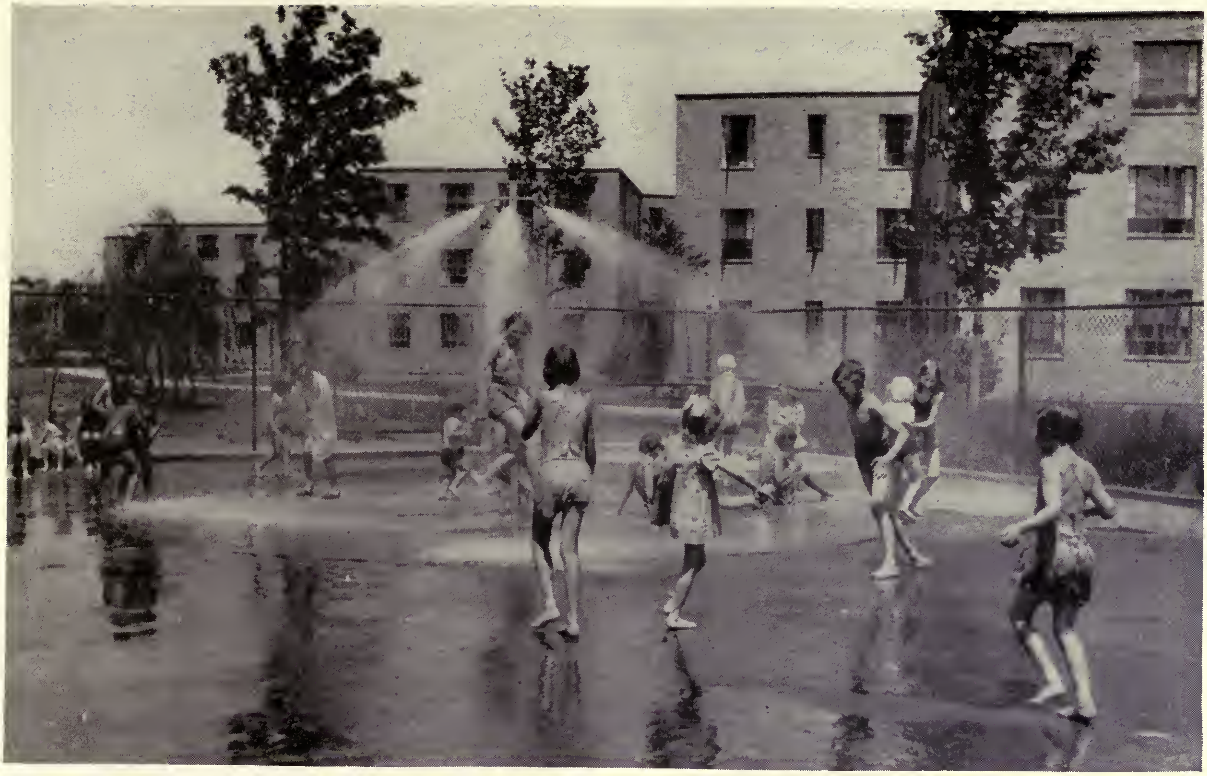
The most satisfactory spray seems to be one of drops simulating rain—that is, neither very fine drops, approaching mist, nor solid streams breaking into large drops. A good intensity has been found obtainable from about 5 GPM of water per 100 square feet of pool area. (The Josam or Zurn dome-type spray head delivers a little over 30 GPM at 10 pounds pressure.) The spray preferably should not descend vertically at the sides since small children like to step into it without getting their eyes filled with water.

Several types of spray heads and settings have been used. The dome-type of spray head with a pressure-reducing valve is considered superior to the bath-shower type or to small nozzles. The nozzles generally give too fine a spray; the bath-shower heads give too great an intensity.

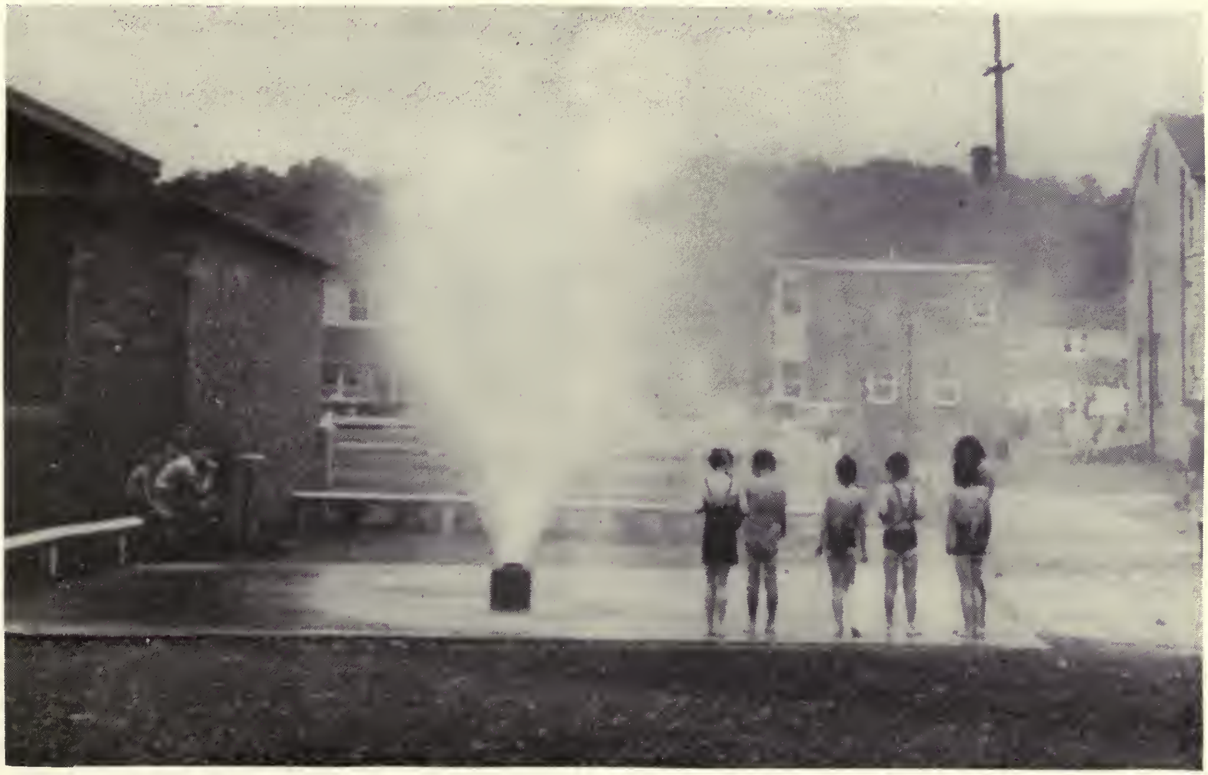
Location of the spray head at one side of the pool, so that the spray is discharged at an upward angle of 45°, gives more satisfactory coverage of the spray pool than a central location with the spray discharging vertically from either a high or low standard.

The use of two or more spray heads, located at

Curbs are tripping hazards



This pool area is too small for heavy sprays



A pressure-reducing valve is needed

Low spray heads can be blocked by children

intervals which will give a maximum coverage with a minimum of overlapping, is recommended for large spray pools.

The location of controls is important. The control valve should be within sight of the spray pool, and convenient for the recreation director, but out of reach of the children. A location such as a basement room in the community building, a boiler-room, or even the recreation director's office usually is the most satisfactory. (Note, however, that a stop-and-waste valve, at an elevation well below the pool level, is necessary to permit draining the spray piping.) The second choice is a special masonry chamber with an indestructible cover and lock near the spray pool. Location in a crawl space is inconvenient for the recreation director.

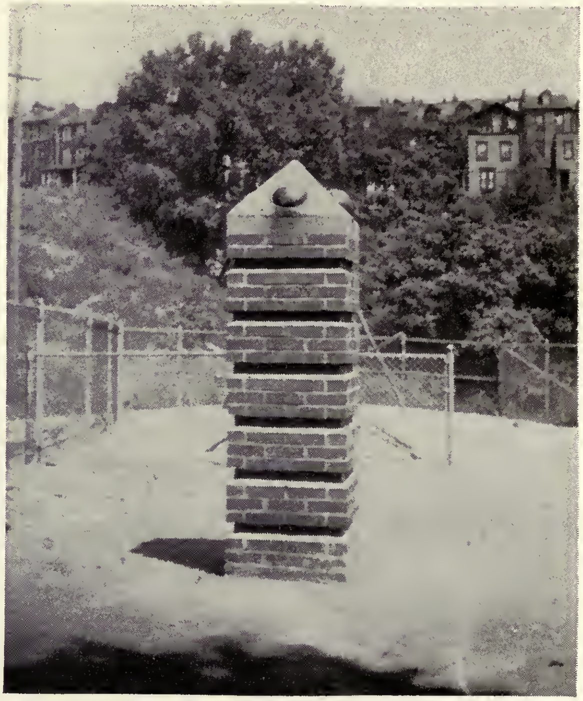
To provide proper drainage is important but difficult. A perforated plate is better than a grating, since it makes the area more usable for other play purposes. No drain has been developed, however, which cannot be stopped up by trash, frequently collected purposely by children in an attempt to convert the spray area into a pond. In some instances they have removed the drainage casting. Some authorities recommend the use of a device to retain the water when desired, so that the spray pool can be used also as a wading pool.

> Grating at drain of spray pool — a great temptation for kids to remove. It was found necessary to weld these in place. — North Carolina

Managers are not unanimous in their recommendations on the height at which the spray heads should be placed.

In a number of projects, where spray heads are located close to the floor of the spray pool or on low standards, managers report difficulties due to the danger of people tripping over them, to the blocking of the spray by children sitting or standing on the spray head, or to their filling the holes with gravel, sticks or other debris. As a remedy for both problems a height of 7 feet for the spray head has been recommended by several managers.

> Low spray heads are satisfactory. — North Carolina
>
> The spray head is low and presents a danger from stumbling. The manager would like to have it raised to make it more conspicuous. — Ohio
>
> So that spray pools may continue to spray instead of being smothered by a tightly wedged miscellany of pebbles, sticks and scrap iron, the spraying nozzle was raised to the top of a concrete capped brick pillar about 7 feet high. — Pennsylvania



Substantial spray head standard affording unobstructed spray

Water Distribution

SOURCE OF PROJECT WATER SUPPLY

All low-rent projects so far built receive their water supply from local water works systems. Independent supply works were seriously considered in a few instances where water rates were extraordinarily high or connection to existing systems was quite costly, but no new supplies were developed. The decision in such cases must be made at the time of site selection and the local authority should assume the responsibility of operating a water supply plant only when a site possesses exceptional advantages otherwise, and when competent investigation proves that a supply can be developed and maintained at reasonable cost. The discussion following relates solely to water distribution.

METHOD OF WATER SERVICE

The cost of water to tenants is the foremost consideration in planning water service. In the majority of projects, water is master-metered: sometimes through a single meter, sometimes through two or three meters (for security against interruption in service), and sometimes through "group" meters (one meter to each group of dwellings or buildings). In the latter two cases, arrangements have been made, when possible, for consolidating the meter readings, thus obtaining the benefit of a "wholesale" rate. In a number of instances, however, local regulations or unusual rate structures have resulted in the installation of a meter on the service to each dwelling.

The points which most often require negotiation with the local water department are (1) obtaining for the project a special water rate, such as is scheduled for water sold to institutions, (2) consolidating the readings of two or more meters, (3) extending street mains for domestic water service to the project, and (4) providing fire protection lines and hydrants without cost to the project. The project distribution system can be laid out only after agreement has been reached on such matters.

In analyzing water costs—balancing annual costs against first cost—for different methods of serving a project, the assumed average water consumption can best be based on that of projects operating in the locality. Lacking such information, or as a check on it, a figure may be derived from Table VI. It should be emphasized, however, that water consumption in housing projects varies widely.

Table VI shows a relationship observable in operating statistics between size of city and water consumption.

TABLE VI

WATER CONSUMPTION IN PUBLIC HOUSING PROJECTS[1]

(Rough averages based on records for 100 projects)

Population of city in which project is located	*Average daily water consumption per dwelling*
	Gallons
10,000	150
100,000	175
1,000,000	200
5,000,000	250

[1] Averages for the year. Rates given are exceeded materially in arid and semi-arid regions.

DISTRIBUTION SYSTEM DESIGN

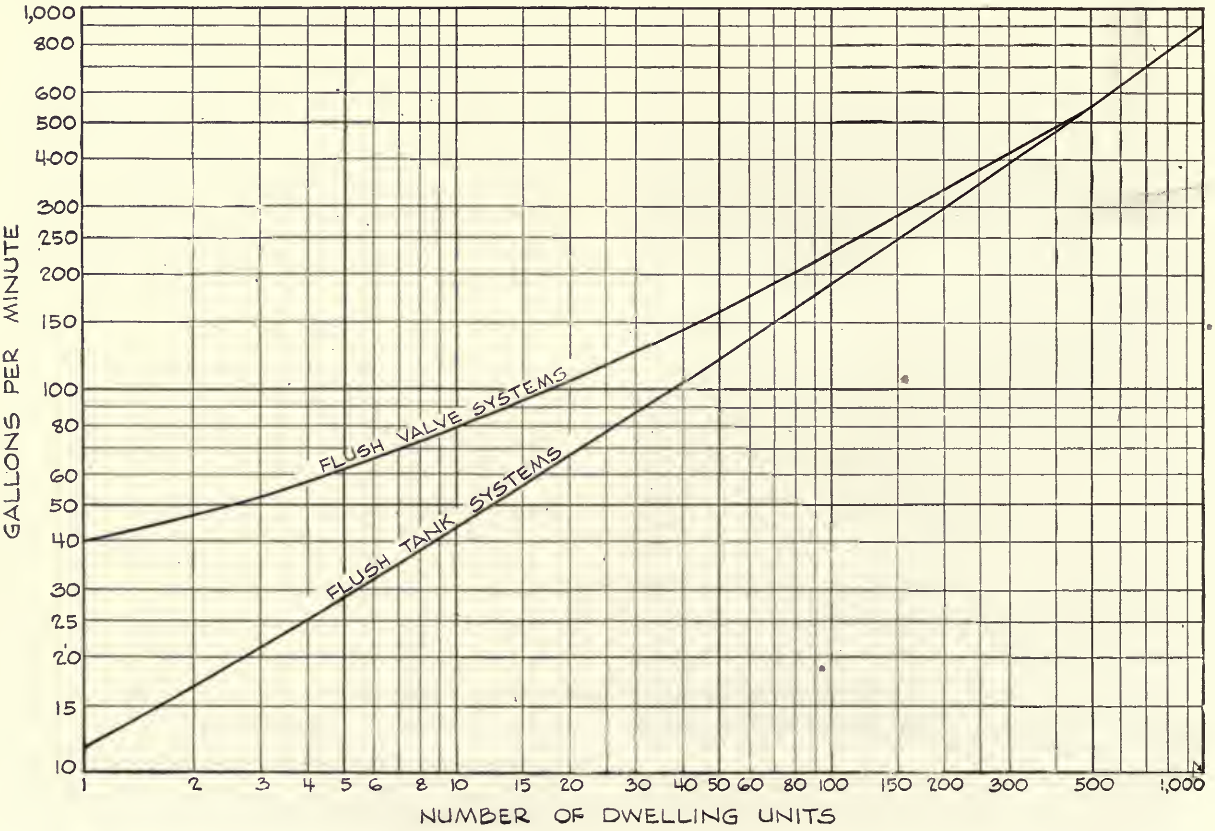
The utility map of the project site, prepared under the survey contract, is intended to furnish certain information on existing water mains, fire hydrant locations, working pressures, and so on needed for the project distribution system design. Ordinarily, however, the utility map shows only the mains within or immediately adjacent to the site. Unless these lines are of ample size and are connected to important feeders, their working pressure when fire-fighting apparatus is drawing on them, or even when there is a heavy domestic demand by the project, may be much less than the pressure before project occupancy.

This is a matter requiring investigation at the time of site selection, and it is obviously one on which the designing engineer must be informed accurately. Except for sites centrally located in a community, fire-flow tests are often, if not always, necessary to check the adequacy of the supply.

Estimated peak demands for domestic water supply, arrived at through extended study and investigation, are shown in Figure 1. The indicated demands may be considered somewhat high for apartment projects, where the lawn-sprinkling demand will be light, and slightly low for low-density projects in arid or semi-arid regions. For cold-water distribution only (hot water distributed from central heating plant) about 20 percent may be deducted from the indicated demands.

Experience has shown the desirability of having some general guide for project fire main design. Table VII has been prepared for the purpose. It should be emphasized that the quantity of water required for fire protection is affected by fire risks from adjoining properties as well as by the characteristics of the project itself; further, that local practice must be taken into account and advice obtained from the City water department or from engineers of the fire insurance bureau in the State.

Figure 1. Estimated peak demands for domestic water supply



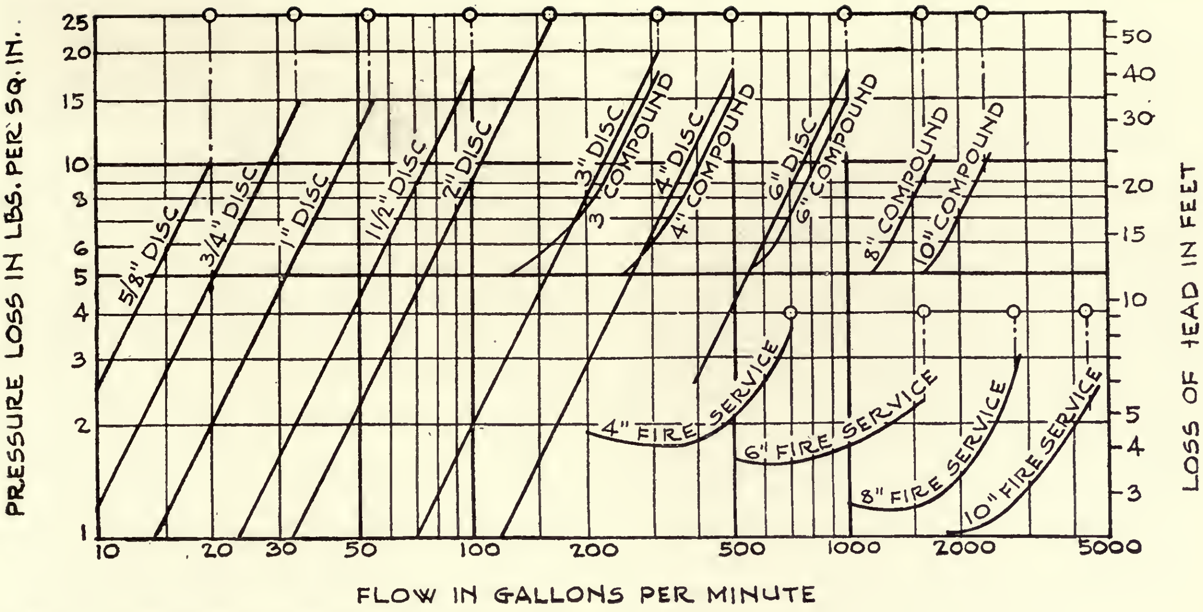


Figure 2. Pressure loss through water meters

TABLE VII

RECOMMENDED FIRE FLOWS

Type of project	*Fire flow (single fire)*
Three-story apartments Two-story row houses and flats.	750 GPM from any hydrant or 1500 GPM from any two adjacent hydrants.
One-story row houses	750 GPM from any hydrant or 1000 GPM from any two adjacent hydrants.
Single or twin houses	750 GPM from any hydrant.

TABLE VIII

TOTAL FIRE DEMAND[1]

	GPM for Average City Population
1,000	1,000
2,000	1,500
4,000	2,000
6,000	2,500
10,000	3,000

---

[1] Adapted from "Table of Required Fire Flow", in the National Board of Fire Underwriters' "Standard Schedule for Grading Cities and Towns". New York.

Table VII is suggested mainly for checking purposes and the fire flows given are for single fires. The total fire demand must be related also to the size of the project, particularly on outlying sites. A generally reliable basis for this is given in Table VIII.

In brief, hydraulic calculations should take into account the following factors:

1. Water supply demands (discussed above).
2. Initial pressure (discussed above).
3. Requisite residual pressures, approximately as follows: 15 p.s.i. minimum at fire hydrants, for engine streams; 50 p.s.i. minimum (if available) at fire hydrants, for direct hydrant streams; 8 p.s.i. minimum at plumbing fixtures, excluding flush valves; 15 p.s.i. minimum at flush valves.
4. Pressure loss through meters (see Figure 2).
5. Pressure loss through distribution system.
6. Pressure loss through building piping.
7. Static gain or loss due to difference in ground elevation.

Water lines cannot be sized safely and economically by guess, although that method, regrettably, has sometimes been employed.

Fire mains are usually located within the lines of existing streets or of streets and drives to be dedicated; domestic supply piping is laid out in whatever way will minimize pipe quantities both outside and inside buildings.

MATERIALS AND APPURTENANCES

The distribution system should be to the greatest possible extent, of materials that will not require replacement during the period of project debt amortization. Information should be available locally concerning the durability of different kinds of pipe and the decrease in the pipe's capacity with length of service under the given conditions. This information, together with a chemical analysis of the particular water supply, will be the best guide in selecting pipe materials, especially for domestic supply lines.

Fire hydrants in housing projects are commonly spaced about 400 feet apart and, when practicable, are so located that each building can be reached from two hydrants with a maximum hose length of 300 feet from each. Hydrants are sometimes set too close to the building which is to be protected; they should be at least 25 feet distant, 50 feet if possible. It is important that hydrants be of the same type and have the same nozzle thread as those used locally.

Valves (or cocks) are commonly provided at intervals in long mains, on branch lines near their points of take-off, and on all services. A uniform position for valves throughout the project—for example in line with curbs or sidewalks—has been found desirable, in order that the valves will be located readily in case of emergency.

Hydrants should be set to finished grade

Although one of the principal criteria governing site selection is soil stability, it is the engineer's responsibility to protect water lines, as well as other utilities, if unstable soil is encountered. Experience has shown that an important precaution to be observed is the provision of flexible pipe or flexible joints at building walls.

PROTECTION OF WATER SUPPLY

The following design measures and procedures directed toward preventing contamination of the project water supply merit special emphasis:[1]

1. Omission of physical connection between the water distribution system and the sanitary sewer system, for example, sewer connections to meter chambers or hydrant drain pits.
2. Separation of water and sewer lines by laying them in different trenches (10 feet apart where practicable) and by keeping the sewers below the water lines.
3. Omission of underground, combination stop-and-waste cocks.
4. Provision of fire mains of adequate capacity so that pumpers will not cause negative pressure.
5. Disinfection of joint packing material. (This has not been common practice, but it may obviate serious difficulty in sterilizing the system, or even subsequent contamination of the water supply.)
6. Making sure that pipes are clean when lowered into the trench and that dirt or trench water does not enter them during the laying operation.
7. Sterilization of the entire water distribution system following its completion.
8. Avoidance of dual water systems, one for domestic supply and one for fire protection or irrigation. (If dual systems are unavoidable, there should never be any cross-connection between the two, and every precaution should be taken to prevent possible use of the non-potable supply for domestic purposes.)

---

[1] See also "Public Health Service Drinking Water Standards and Manual of Recommended Water Sanitation Practice", U. S. Public Health Service. Government Printing Office, 1943.

Gas Distribution

BASES OF DESIGN

The gas supply for low-rent projects is usually obtained by wholesale purchase, the utility company delivering the gas from a metering station located at or near the border of the project. The present text applies to this method of service. The service contract with the gas company should stipulate the minimum Btu content of the gas, the minimum pressure at which it will be delivered (on the project side of the meter installation), and the point of delivery. This information is prerequisite to project distribution system design.

The peak demand for gas is not susceptible of accurate estimate and will vary with the climate, tenants' customs, and character of the project. Nevertheless, some reasonable design basis must be employed and Figure 3 has been prepared to show approximate peak-hour loads for varying numbers of dwelling units and different uses of gas (except for space heating). The indicated loads can be considered to include but a small allowance for the incidental use of range ovens for space heating. Therefore, in the case (1) of projects in which dwellings will be "tenant-heated" and gas "project-supplied", or (2) of communities where it is common practice to use range ovens for space heating, additional allowance may be necessary to cover this extra demand. Under the first condition just noted, consumption records have demonstrated that range ovens are used extensively for incidental space heating; on at least one project, gas pressure was reduced to a hazardous extent by that practice.

The peak-hour load for space heating (by regular heating appliances) will more nearly approach 100 percent of the connected load than will that for any other use of gas. The following diversity

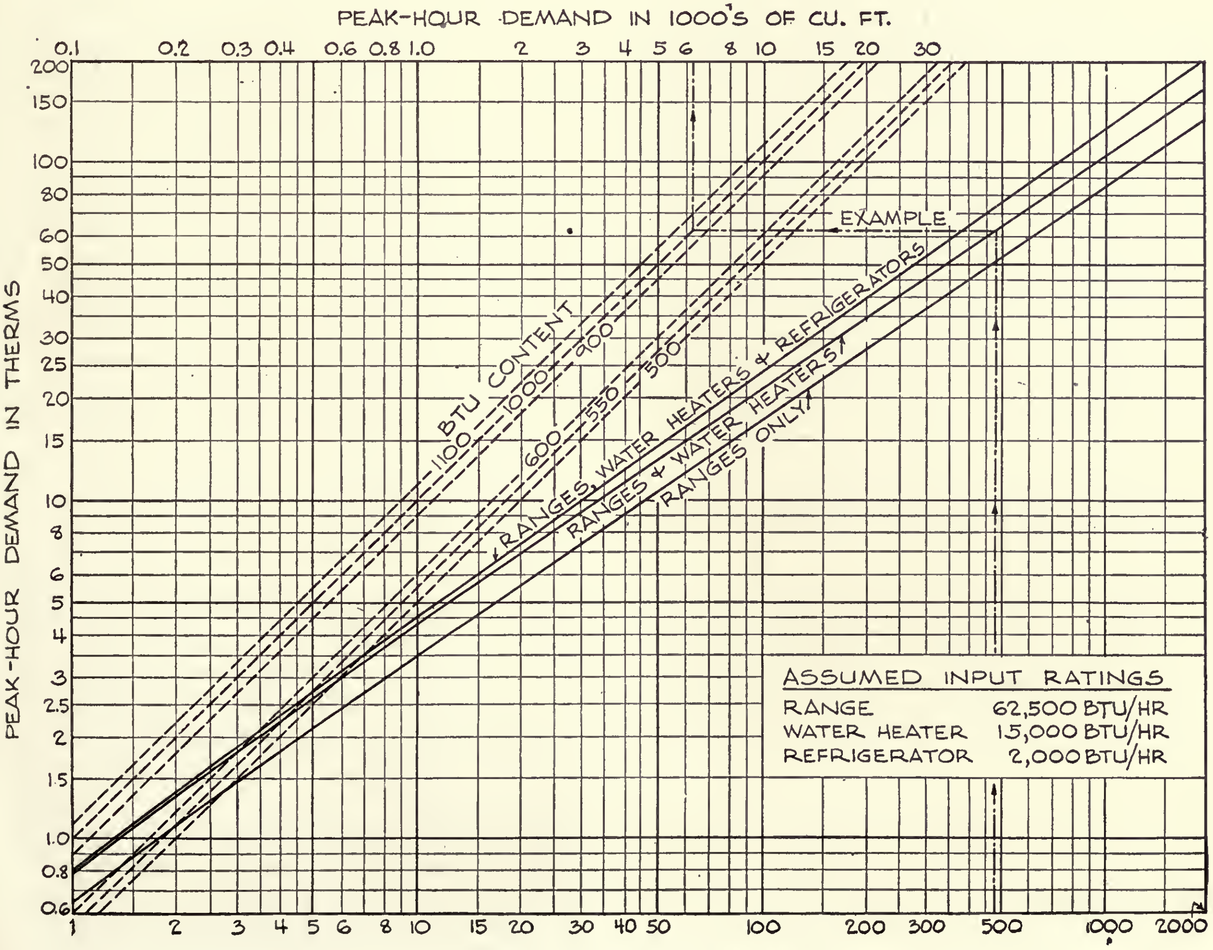


Figure 3. Peak-hour loads for gas uses (except space heating)

factors[1] are suggested for reducing connected heating loads to peak-hour loads:

Number of DU's	*Diversity factor, percentage*
1	100
10	95
25	90
100	85
300	80
1000 and over	75

The peak-hour heating load should be added to that for other uses of gas, as derived from Figure 3. The input ratings of gas-fired heaters and furnaces for public housing vary from about 30,000 to 60,000 Btu per hour per dwelling. Space heating requirements for project facility buildings must also be considered.

In common practice, gas piping within buildings is sized for a pressure drop of 0.5 inch between the service connection and the appliances. Thus, allowing for an additional 0.5 inch loss through a check meter and a residual pressure of 3 inches at appliances, the pressure at the building wall should be not less than 4 inches. With intermediate pressure distribution, the residual pressure at house regulators (on the high-pressure side) should be not less than 1 pound (some regulators require 2 pounds).

Low-pressure[2] distribution is most common for manufactured gas, intermediate-pressure[3] distribution for natural gas. However, one of two conditions may warrant low-pressure distribution in a housing project, even when a high-pressure[4] supply is available:

1. When it is altogether improbable that the high-pressure supply will remain available for the life of the project.
2. When the length of mains and service branches will be less than about 35 feet per dwelling unit. (Under this condition, which may occur in projects of high density, low-pressure distribution is usually cheaper. Alternate comparative layouts will determine this point.)

PIPE SIZING

Since engineering handbooks rarely contain conveniently arranged tables or diagrams for gas line sizing, three such diagrams, Figures 4, 5 and 6, are supplied with this text. The essential steps in their use, that is, in sizing a gas distribution system, are shown in the following example.

1. *Basic Information.* 480-DU project; gas to be used for cooking and water heating; 550-Btu gas, Sp. Gr. 0.45; available pressure drop—5 inches initial less 4 inches at building wall equals 1 inch (low-pressure system).
2. *Loading.* The length of the principal and longest run of piping from master meters to any building is 2000 feet. The second column of Table IX shows the peak-hour loads derived from Figure 3 at various critical points along this line.

TABLE IX

EXAMPLE OF PIPE SIZING

Number of DU's	*Peak-hour load*	*Indicated pipe diameter*	*Adopted pipe size*
		Inches	*Inches*
480	11,000 c.f.	7.4	8
432	10,500 c.f.	7.2	8
360	9,100 c.f.	6.8	8
288	7,800 c.f.	6.3	6
216	6,400 c.f.	5.8	6
144	4,800 c.f.	5.3	6
72	2,800 c.f.	4.3	4
36	1,750 c.f.	3.5	4
24	1,300 c.f.	3.1	3
18	1,000 c.f.	2.8	3
12	750 c.f.	2.5	3
6	450 c.f.	2.0	2
4	360 c.f.	1.85	2
2	240 c.f.	1.60	1½
1	145 c.f.	1.30	1¼

3. *Sizing.* Enter Figure 4 at 2000 feet in the right-hand scale, proceed horizontally to "1-inch pressure drop," thence vertically upward or downward, and from pipe capacities on left hand scale take off the indicated pipe diameters, as shown in the third column of Table IX. It will be noted that the adopted pipe sizes (fourth column) usually afford a slight margin of capacity above the estimated requirement. This precaution is believed advisable as insurance against the possibility of the design loading ever being exceeded

---

[1] Ratio of the peak-hour load to connected load.

[2] Not more than 0.50 lbs./sq. in.

[3] Between 1 and approximately 20 lbs./sq. in.

[4] More than 20 lbs./sq. in. Usually 50 pounds and upwards.

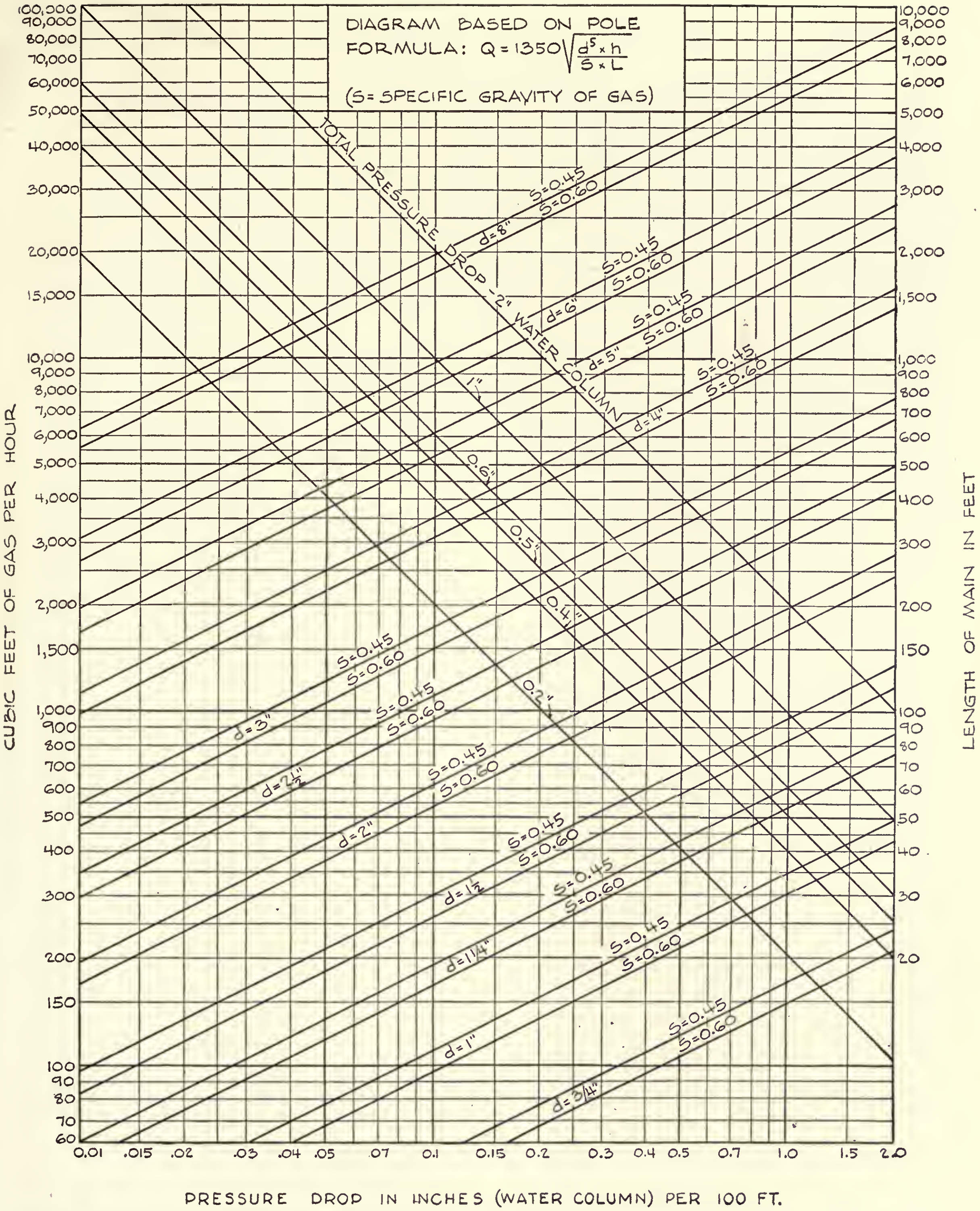


Figure 4. Gas line sizing diagram—low pressure

to a hazardous extent. A procedure similar to that just outlined is followed for shorter runs.

For intermediate-pressure systems the only variation from the procedure above lies in the use of the

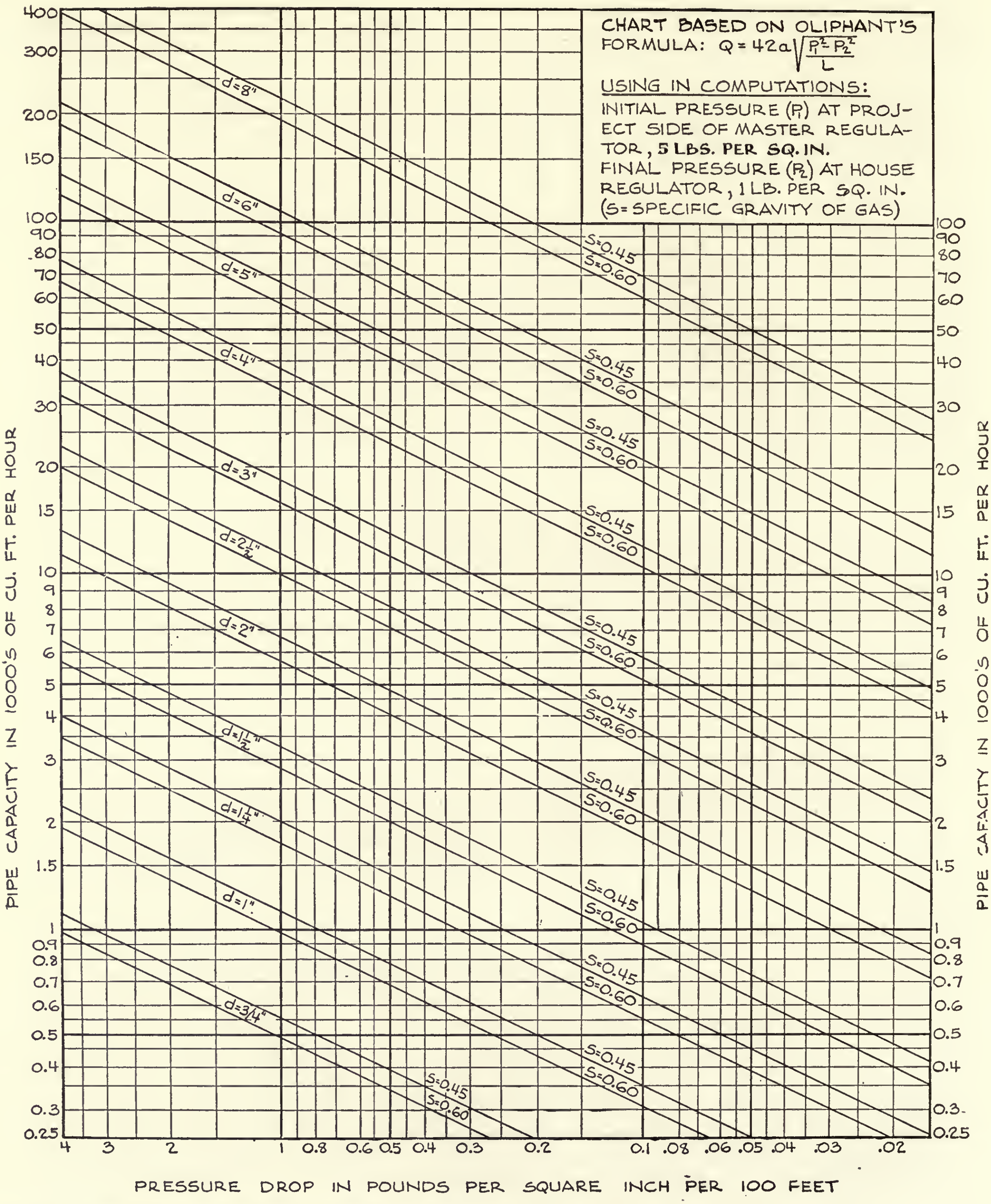


Figure 5. Gas line sizing diagram—intermediate pressure
(Pressure drop of five pounds to one pound per square inch)

diagrams. It is necessary to figure the available pressure drop per 100 feet, then enter Figure 5 or Figure 6, as the case may be, on the bottom scale. These diagrams obviously cover only two condi-

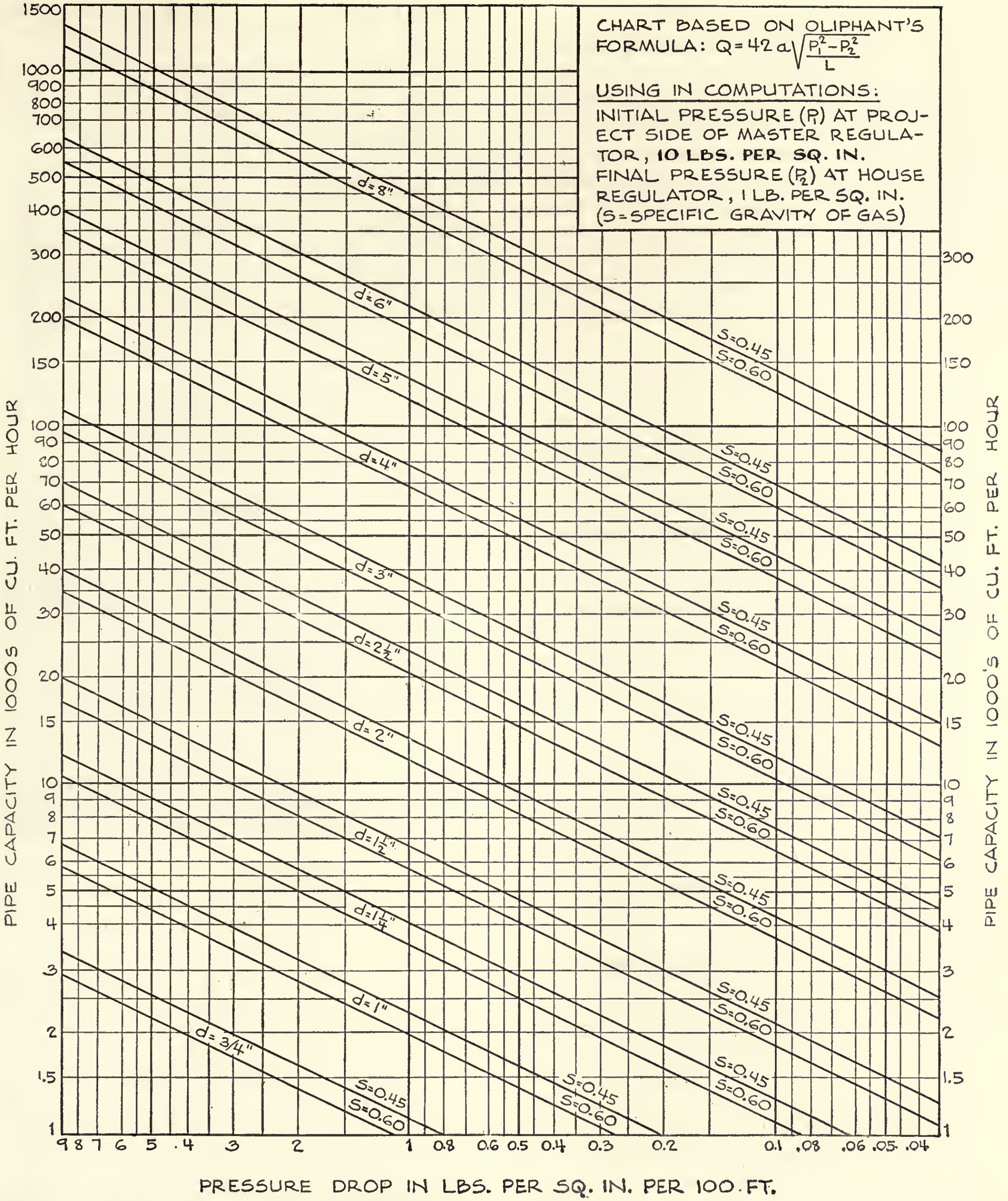


Figure 6. Gas line sizing diagram—intermediate pressure

(Pressure drop of ten pounds to one pound per square inch)

tions, namely, pressure drops of from 5 pounds to 1 pound, and from 10 pounds to 1 pound, respectively; but they have been found usable in the majority of cases.

LAYOUT OF MAINS AND SERVICES

The gas distribution system consists essentially of (1) main distributors, starting at the master meters and following streets and drives so far as practicable, (2) secondary distributors, paralleling buildings or otherwise located so as best to serve groups of dwellings, and (3) service connections to individual dwellings or buildings. In many cases services connect directly to the main distributors.

The radial system of distribution provides flow in one direction only. Theoretically this system allows the most direct runs of piping from the master meters to project dwellings and results in lowest costs. The preceding example of design was based on this system of distribution. The loop system of distribution is, as the term implies, that in which lines are interconnected so that the gas flow may be in either direction. The system adds to pipe quantities but it provides greater security of service and is widely used in gas distribution. However, main distributors in the form of full-sized loops, practically encircling projects, usually are wasteful and unnecessary; and secondary distributors, if everywhere looped and liberally sized, will cost more than their worth to the project.

Comparative estimates are necessary in each case to determine whether buildings in parallel rows can be served more economically by a single secondary main centrally located or by separate distributors located close to the buildings. Gas distribution lines never should be buried under buildings, nor should they be laid in the same trenches with sewers or electric conduits.

DISTRIBUTION SYSTEM APPURTENANCES

The master gas meters—also the "project" regulators, if gas is from a high-pressure supply—are furnished by the gas company as a rule. Housing should be of fire-resistant construction, with special provision for ventilation. House regulators are usually placed to serve at least two dwellings.

In common practice, fewer valves are used in gas distribution systems (especially in low-pressure systems) than in water distribution lines. Operating difficulties have been experienced, however, due to lack of valves in gas systems serving housing projects, and the following practice is recommended: (1) valves at intervals in long main distributors only when the distributors are looped, (2) valves in secondary distributors near their point or points of connection to main distributors, and (3) a stop in each house service.

Distribution systems for manufactured gas, also in some cases for natural gas, are planned for drainage to drip pots located at all low points.

PIPE MATERIALS

As in the case of other underground utilities, gas lines should, if possible, be of materials which will not require replacement during the period of debt amortization. Project cost limitations may be an important consideration but essentially the choice of pipe material should be based on minimum annual costs, mainly capital costs. A simple method of comparing capital costs is illustrated in Table X.

TABLE X

CAPITAL COST COMPARISON

	Material A	*Material B*
Assumed useful life	30 years	60 years
Estimated present cost, installed	1.00	1.30
"Present worth" (3 percent interest basis) of estimated replacement cost: 41 percent of 1.15	.47	0
	1.47	1.30

Under the foregoing assumptions (they should in all cases be favorable to the use of the least costly material) the longer life material is indicated to be slightly the more economical. The cost of replacement is assumed to be somewhat greater than the present cost because the work would be performed after roadways are paved and project grounds landscaped.

Pipe used in gas-distribution systems usually has been either cast iron or steel, although wrought iron has been laid in some instances. Local experience should be the best guide in estimating, for the given soil conditions, the life of different kinds of pipe with their coverings (if any). When steel pipe is laid, care should be taken to specify a most durable covering. For cast-iron pipe, project experience has shown that ordinary lead-and-jute joints are not satisfactory.

Sewerage

DISPOSAL OF PROJECT SEWAGE

Sewage from FPHA-aided projects has been disposed of in three ways:

1. By connection to an existing municipal sewerage system—the most common method and the most advantageous, unless the cost is excessive. It is particularly desirable that housing management not be responsible for operating sewerage treatment works.
2. By septic tanks and tile absorption fields serving small groups of houses—a method that has been employed only occasionally and almost always with unsatisfactory results, notwithstanding apparently favorable soil conditions in most cases.
3. By a project sewage treatment plant—a method rarely used in low-rent developments, although of necessity employed widely in the war housing program. For permanent projects, the method obviously can be justified only for a site which, lacking sewerage facilities, otherwise possesses outstanding advantages.

The method of sewage disposal for each project will have been decided at the time of site selection. Nevertheless, the site engineer must check the decision and make sure that the method proposed meets the approval of the State Health Department.

DISPOSAL OF STORM WATER

The disposal of storm water has constituted one of the more serious problems in project development due to (1) failure to appreciate its importance in site selection, (2) insufficient information regarding pertinent local conditions, even at the time of project design, and (3) unstudied design. As a consequence, some projects have suffered severe damage, tenants have been inconvenienced at times by mud and water, and in a few instances sewage from combined sewers has backed up into basements or has flooded open areas. Certainly storm sewers are not so essential as sanitary sewers. Proper drainage, however, should not be considered a luxury where its lack would lead to heavy outlays of project funds, either occasionally in large amounts to repair severe damage or in relatively small sums for continued maintenance.

The need for downspout connections may be the controlling consideration in deciding whether or not a comprehensive system of project storm sewers should be provided. Such connections have definitely been recommended by some management authorities to prevent dampness in basements and crawl spaces and to reduce soil erosion. However, climate, topography and the nature of the soil should be considered in each case, since downspout connections may be an important item of cost in low-density projects, especially if the buildings have ridge roofs requiring drains on both sides.

Public housing sites have presented a variety of conditions as regards storm water drainage. In some areas separate storm sewers were available; in others, combined sewers; in still others the only existing drains were the natural water courses. And where there were storm or combined sewers at hand, often their capacity was insufficient to protect the sites against periodic flooding. Even in the centers of communities storm or combined sewers may prove inadequate. Also visual evidence that the land to be developed has "good, natural drainage" cannot be accepted as an indication that there will be little difficulty in finding an outlet for storm water. Hence the storm water problem, like that of sanitary sewerage, becomes a matter for some advance study and consideration before sites are finally selected.

INVESTIGATION OF LOCAL CONDITIONS

Reliable information about existing storm and sanitary sewers is often hard to get. In a number of projects the inadequacy of existing facilities was discovered only after construction was well advanced. A field inquiry may be necessary to learn if back-flow into basements or street flooding has been experienced in the area during heavy rains. Possible future changes must be taken into account. The municipality may contemplate extension or enlargement of the present system, or additional construction may result in seriously overloading the present system.

Difficulties that may create future project expense stem not only from the availability and capacity of the systems themselves, but also from subsurface soil conditions. Some soils have a greater capacity to absorb normal rainfalls than others, and some have better qualities for resisting the erosive effect of heavy runoff. Still other subsurface conditions create heavy installation cost or burdensome maintenance charges because of the settlement of sewer lines.

Such conditions will have been investigated in a general way, at least, at the time of site selection, but it is incumbent on the designing engineer to check previous findings and to possess full knowledge of the situation. Experience shows that too much attention cannot be devoted to advance determination of the problems to be faced in design, or to the design itself.

Flat site, six feet above sea level. No storm drainage system. Water theoretically drains off into areas between houses and out to a drainage ditch paralleling the highway. Actually water stands several inches deep in greater part of streets after a rain and "drainage area" back of house is a swamp for several days after. — Virginia

The following brief summary highlights design features which, although fundamental, are frequently overlooked.

SANITARY SEWER DESIGN

The maximum rate of sewage flow from large groups of houses seldom exceeds three times the average rate, though it may be augmented somewhat by infiltration. Thus project sanitary sewers may be designed safely for flows, at full capacity, of 1000 gallons a day for each dwelling unit—five times an assumed average of 200 gallons a day. This rate may be increased slightly for small projects and decreased for large projects.

Standard design practice calls for a velocity of not less than two feet per second in sewers flowing full or half full. (The relation of flow velocities to grades is shown in Figure 7.) Lighter grades often are employed, however, in order to avoid pumping or deep trenches; in such cases it is especially important to work out a consistent system of grades and so utilize to best advantage all the fall available.

Although conservative practice calls for 6-inch pipe in sewer house connections and 8-inch in laterals, 4-inch sewer pipe has been used in many projects to connect to the 4-inch cast-iron building drains, and 6-inch pipe has been used for short laterals, especially when the latter are not located in streets or drives. No difficulties attributable to this practice have been reported.

The custom of providing manholes at all breaks in line or grade is not followed rigidly in the design of low-rent developments since an excessive number of manholes would often be required as a result of irregularity in the arrangement of buildings.

Clean-outs usually can be substituted for manholes at the upper ends of laterals and at changes in line or grade of short 6-inch lines. Terminating clean-outs below the ground surface in order to eliminate covers in lawn areas has proved satisfactory only when the ground is not subject to deep frosts and when clean-outs are carefully referenced so that they may be located readily.

Obviously, the use of sewage pumps should be avoided wherever possible, through care in site selection and through intelligent design. Dry-well type pumping installations have been found much more satisfactory than wet-well, and superstructures over motor rooms well worth their cost. Emergency overflows should be provided when at all practic-

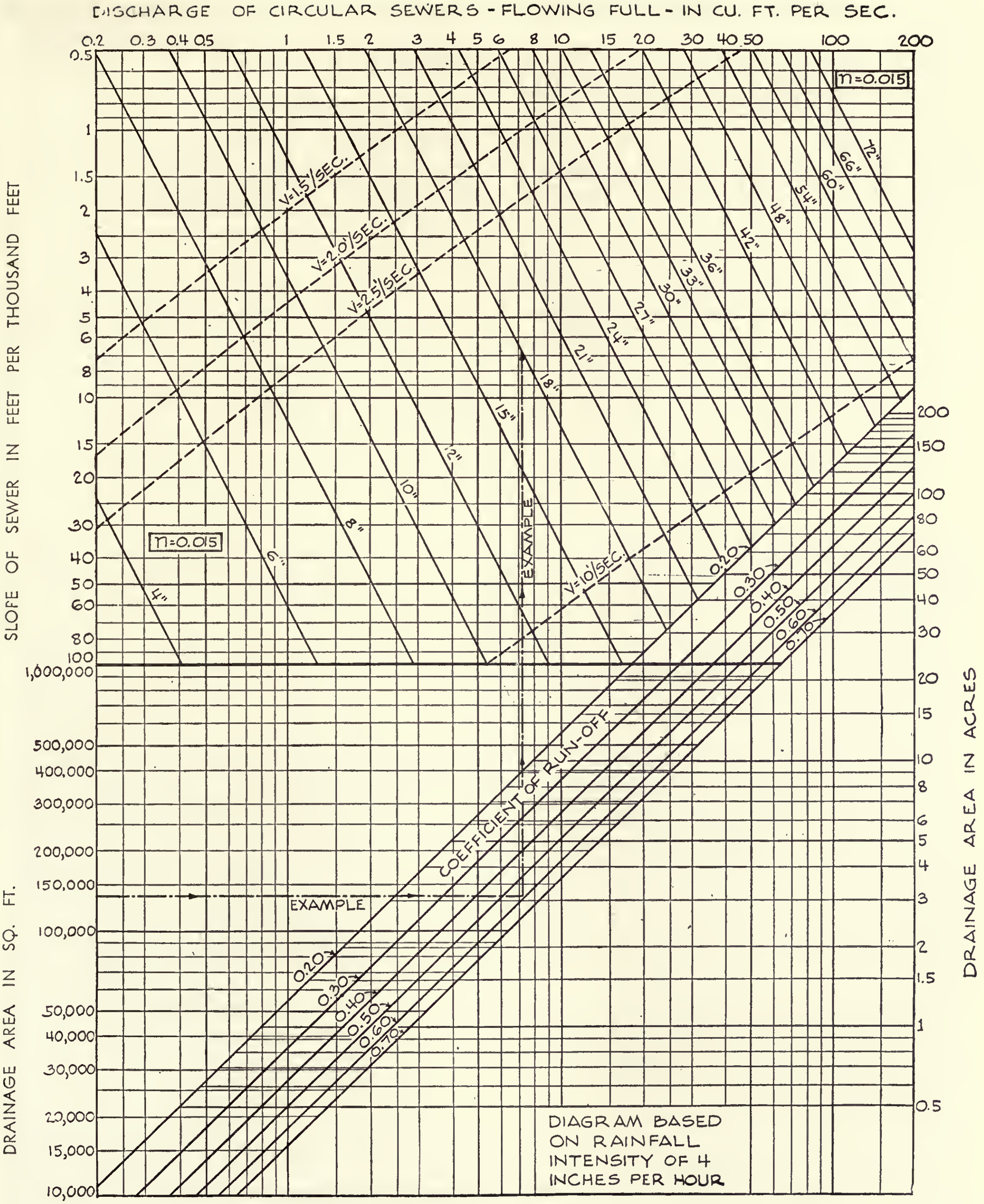


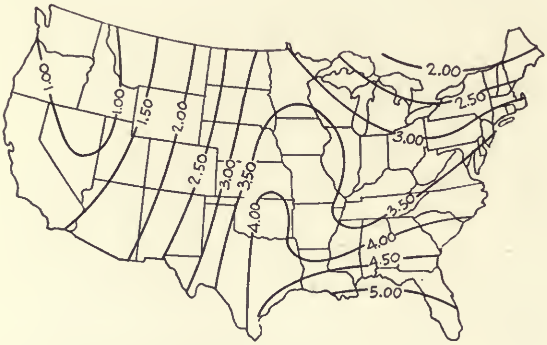
Figure 7. Storm sewer sizing diagram

able; stand-by power has been provided in some instances.

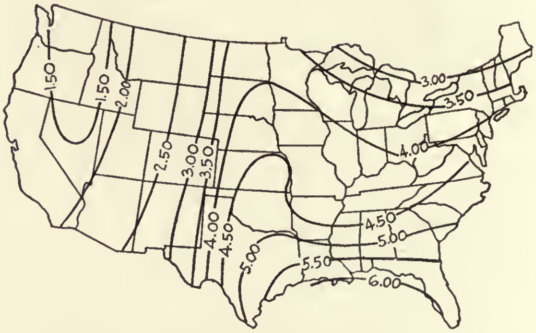
With reference to the sewer layout, design objectives proved important to housing projects include (1) locating mains in street and driveway areas wherever possible to relieve the project of their maintenance if streets and drives are dedicated later, (2) locating lines so as to avoid trees, and (3) co-ordinating lines with locations and grades of other project utilities, particularly storm sewers and steam and hot-water conduits.

STORM AND COMBINED SEWER DESIGN

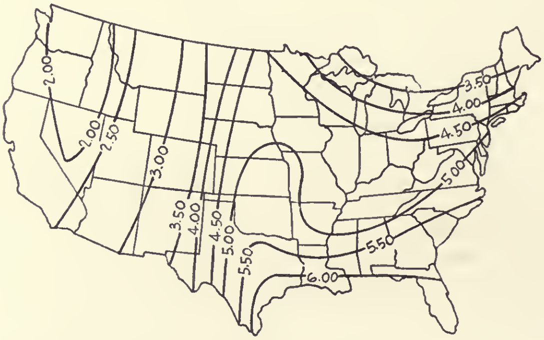
Experience has shown that project storm sewers or combined sewers cannot be designed perfunctorily and at the same time safely and economically.



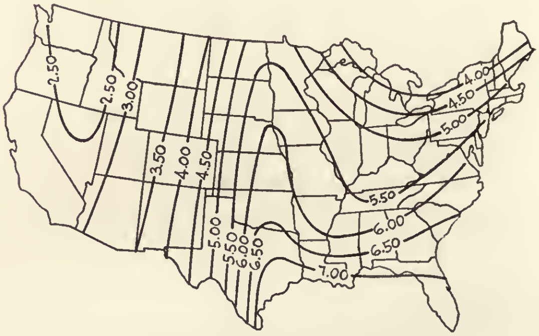
15-MINUTE RAINFALL - IN./HR. RATE
TO BE EXPECTED ONCE IN **2** YEARS



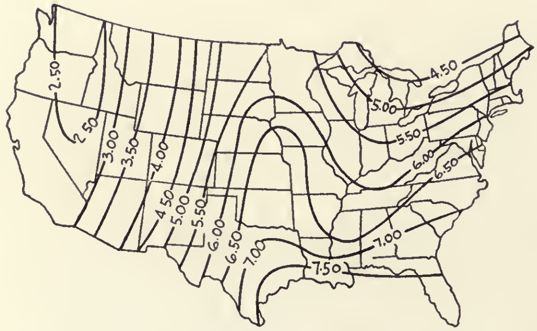
15-MINUTE RAINFALL - IN./HR. RATE
TO BE EXPECTED ONCE IN **5** YEARS



15-MINUTE RAINFALL - IN./HR. RATE
TO BE EXPECTED ONCE IN **10** YEARS



15-MINUTE RAINFALL - IN./HR. RATE
TO BE EXPECTED ONCE IN **25** YEARS



15-MINUTE RAINFALL - IN./HR. RATE
TO BE EXPECTED ONCE IN **50** YEARS

APPROXIMATE ADJUSTMENTS IN RAINFALL INTENSITIES FOR OTHER THAN 15-MINUTE PERIODS:

FOR 5-MINUTE PERIOD	ADD	45%
FOR 10-MINUTE PERIOD	ADD	20%
FOR 30-MINUTE PERIOD	DEDUCT	30%
FOR 1-HOUR PERIOD	DEDUCT	55%

NOTE:
THESE DIAGRAMS (BUT NOT ABOVE ADJUSTMENTS) REPRODUCED FROM "RAINFALL INTENSITY-FREQUENCY DATA", BY DAVID L. YARNELL - U.S DEPT. OF AGRICULTURE MISC. PUBLICATION NO 204

Figure 8. Rainfall intensities

Even in cities where design practice is soundly established, consideration should be given to each of the following factors entering into the "rational method" of estimating storm water runoff:

1. *Rainfall Intensity.* Cost considerations generally preclude building project storm sewers large enough to handle the runoff during rainstorms of extreme intensity. Hence the "rainfall frequency" assumed should effect a rough balance between first cost and probable future damage. Special considerations are (1) whether the project sewers will be of the separate or combined type, (2) if of the latter, whether buildings will have basements which would be flooded should back-water valves fail to close, and (3) whether the project will contain "pockets" in which flooding would cause serious damage. In cities where extensive rainfall data are not available design rates may be taken from Figure 8. (It is not always proper to assume the same rainfall frequency for sizing all lines.) Since the "time of concentration" is consumed largely in slow flow over unsurfaced areas, 15 minutes is often a satisfactory period to allow for the runoff to reach all lines.
2. *Coefficient of Imperviousness.* Project statistics show that the proportion of the site area covered by buildings and surfacing varies from about 30 percent for low density to 70 percent for very high density projects. The coefficient obviously must be taken from the plans for design purposes in each case.
3. *Coefficient of Runoff.* For impervious areas the runoff coefficient is estimated to vary between about 0.60 and 0.85; for pervious areas it is estimated roughly at 0.10 for light slopes and sandy subsoil, 0.25 for moderate slopes and clay subsoil, and 0.50 for steep slopes and impervious soil.

The inadequacy of existing sewers was discovered during construction

A box sewer built to eliminate an open ditch

Based on experience with projects of varying densities, "combined coefficients" of runoff are approximately as follows:

TABLE XI

COMBINED RUNOFF COEFFICIENTS

Net density of project	*Light slopes, sandy subsoil*	*Moderate slopes, clay subsoil*	*Steep slopes, impervious subsoil*
10	0.30	0.40	0.60
20	.375	.475	.65
30	.45	.55	.675
40	.50	.60	.70
50	.55	.625	.725

(When downspouts are not connected to sewers, reduce by at least 0.05)

The above figures are not design data; they are suggested only for checking, preliminary estimates and similar limited uses. The combined coefficient should be computed for each project. The total runoff in cubic feet per second is of course the product of the area in acres, the rainfall intensity in inches per hour, and the combined runoff coefficient.

To afford reasonable protection against stoppage by trash, the minimum sizes customarily used for project sewers are about as follows ("preferred" diameters are one size larger than noted in each case): 12 inches for sewers draining streets and main drives, 10 inches for sewers draining service drives, 8 inches for sewers draining yard areas.

Minimum grades for storm sewers, according to standard practice, are those that will produce a velocity of at least 2½ feet per second. The relation between sewer sizes, grades and velocities is shown in Figure 7, which has been arranged primarily for storm sewer sizing.

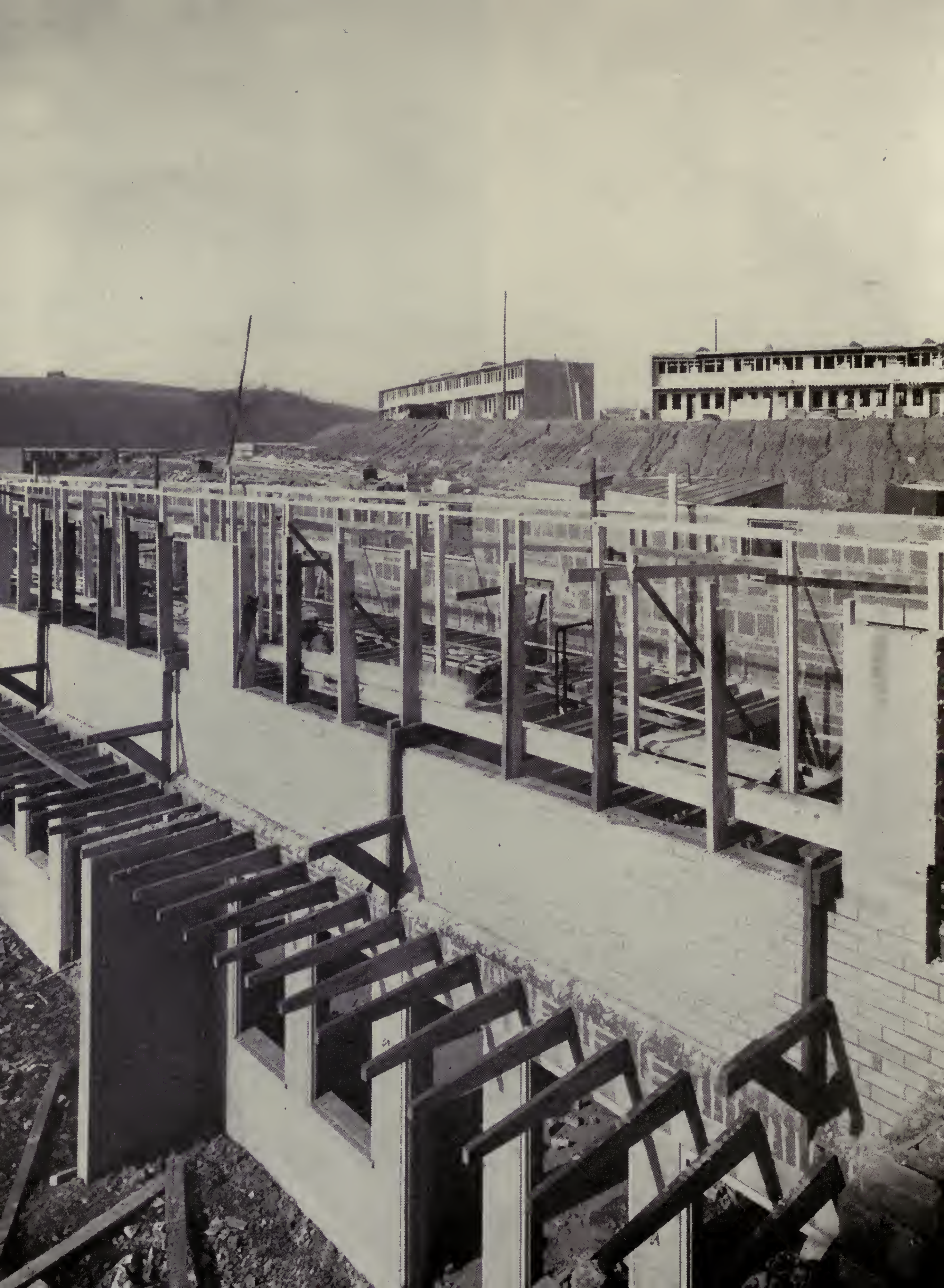
Storm sewer inlet locations are fixed mainly by project grades, but should be checked by the sewer designer for effectiveness and for economy in the sewer layout. Catch basins (inlets with catchment space) are to be avoided when not strictly necessary in favor of plain inlets, in order to avoid cleaning costs as well as breeding places for mosquitoes. Curb-type inlets have proved more effective than surface gratings, but they are not adapted for use in driveways without curbs nor in grassed areas. Surface gratings resting in pipe bells have not been permanently satisfactory. Light-weight castings, unless they have locking device, can be removed by children. It is extremely important that surface gratings be depressed slightly below adjacent grade; failure to do this has resulted in faulty drainage on scores of projects.

> Grating strainers and grills on yard drains and catch basins should be fitted with locking bolts or screws to prevent removing by children. Provide with concrete aprons. — Regional Report
>
> With sandy soil (and in this case falling pine needles) flush grating catch basins are easily choked off, causing puddles, flooding and erosion. Curb-side catch basins would help this. — North Carolina

SEWER MATERIALS, WORKMANSHIP

Engineers for low-rent projects usually have specified clay pipe for sanitary sewers, and either clay or concrete pipe for storm sewers. Bituminous joints have largely supplanted cement-mortar joints for clay pipe installation in housing projects, partly because of greater assurance of good workmanship. Instances of exceedingly poor work have been reported where mortar joints were used.

Special protection is needed, but frequently not provided, for pipe laid in very shallow or very deep trenches. Pipe laid so close to the surface that it may be damaged by construction operations should be of cast iron or be encased in concrete. Pipe-laying in deep trenches should receive close inspection to insure narrow trench width and proper bearing for the pipe; concrete cradling or encasement is required when critical depths are reached for various classes of soil.



The Structure: Its Design and Materials

THIS chapter deals with construction methods and materials, the details of items built into place but not employed structurally, and materials and finishes required to complete the structure; all in relation to their suitability, as proved by experience, for the design of public housing. No attempt is made to discuss the principles of design or to give formulas or data that are available in textbooks. Those are the working tools of the engineer and the architect, and not a substitute for their sound judgment in solving the problems of any particular development.

While the subjects treated here are divided in general into three broad headings—structural design, details, and finished materials—no effort is made to avoid some overlapping of the items; and the items are not covered in detail, as they would be in a specification. The whole field of methods and materials is barely touched; only those major items are discussed which, because of some special point developed by experience, should be of interest to the designer. As a matter of fact the range of methods, details and finishes used in low-rent public housing has been confined to a relatively narrow field; the broad uniformity of the housing program and the enforced necessity for economy in first and continuing cost, has molded most of the projects into a fairly consistent pattern, extremely simple in structural design and use of materials.

On the whole, and with no conspicuous exceptions, the buildings erected so far under the program have fulfilled the requirement that they be "safe, sanitary, and decent" as to structural design and finish. Errors of judgment sometimes have been made; some annoying though not dangerous defects in construction have recurred. Details occasionally have been employed without regard for economy and utility, and materials and finishes have been selected that did not prove satisfactory to the tenants or stand up well under usage.

Since all defects that have been noted are the cause of undue initial cost or lead to excessive operating expense, too much stress cannot be laid upon their avoidance in future work. Early and skillful study is necessary of every aspect of the local program relating to the structural design and to the question of materials, details and finishes. The appropriateness of these to the dwelling types and unit plans, to their particular function and purpose, even to site conditions, and above all, to economy of construction and maintenance, must be given careful consideration by the planners.

CONSTRUCTION SYSTEMS

It might be considered a good general rule to select a system used locally by private industry for comparable operations. It is no mere accident, for example, that in certain areas the majority of fireproof floors are of concrete joists, with tile fillers, while in others solid slabs are customary.

But blind adherence to local practice is not always sound. Local developers do not consistently have the same keen interest in holding down future operating costs that must govern the design of low-rent public housing.

The safest procedure is to make comparative studies of the possible systems applicable to the special nature of the plan, subsoil conditions, and other controlling factors. Since such studies may suggest alterations in plan and outward appearance, they should be undertaken at the same time as—or even before—the first architectural plan studies are made. If planning and architectural style are frozen before the structural studies are made, there may be a tendency to reject the most economical structural system and materials.

These are elementary principles and are well known; they are restated here because of the unusual importance of their application to public housing where every penny of first cost is worth

Caissons used in water-bearing soil

saving and where excessive maintenance expense is detrimental to the purpose of the project. There can be no arbitrary decisions to experiment with untried notions that influence the whole structural design but may prove unfortunate in the end. For example, in the search for economy in the early days of public housing, the idea was conceived that the use of solid concrete floor and roof slabs having smooth soffits would obviate the need for ceiling plaster, saving initial expense and future replacement of ceilings. The adoption of this system had its effect upon the entire structural design and was incorporated in many projects.

Unfortunately, the extra cost involved in providing a smooth surface for the concrete approached, if it did not exceed, the cost saved by omitting the plaster. This is not to say that such a system or similar innovations in design are not possible of successful solution, or that proposals for using new methods and materials should be discouraged. But the fact that projects often consist of several hundred dwelling units means that single errors of judgment can be repeated many times in this kind of development and that one should be on sure ground before innovations are built into so many buildings.

The following paragraphs touch upon the major elements of the structure and cite some of the more significant experiences that have been noted with respect to them.

Foundations

Although most projects have had the usual foundation system—simple bearing walls resting on spread footings—site conditions and special considerations in individual cases have resulted in the use of practically every known method: wood piles; concrete piles, both driven and poured; caissons; deep walls of masonry units or of monolithic concrete; and grade beams supported by deep piers. Each of these has its place and any one may be economically sound if properly employed under the right circumstances. When, for example, heaving soils were encountered, as in parts of the Gulf region, circular ten-inch diameter poured concrete piers with flared bottoms were carried down through this stratum to a stable soil below.

But as a general rule the use of heavy and expensive foundations seems unsuited to low-rent housing, a fact which should be borne in mind when sites are being considered. There was one case, for instance, where a site—a former ash dump—was donated. Even though the buildings were only one-story affairs, deep concrete piles, costing more than appropriate land, were required for their support.

In one large metropolitan area a site having soft and water-bearing soil required caissons for the structures. They were justified on the score of direct slum clearance and over-all economy, but the fact was overlooked (or not given proper weight) that all of the utilities required special provisions to prevent settlement, resulting in a great burden on operating expense.

Water-tight foundation walls are essential in all types of building, especially so in public housing because of the extensive use that is made of basement spaces in apartment buildings for storage, laundering, and varied tenant activities; and because project budgets do not permit of costly repair and corrective work. As a general rule the widespread use of dense, monolithic concrete walls and floors, with natural drainage, or forced drainage where conditions require it, has provided satisfactory results.

Porch floor slabs, platforms, steps and window areaways have settled badly in many instances. This often has been because of careless backfilling; where the porches must be placed over fills or where the ground is naturally soft, posthole auger borings filled with concrete have prevented trouble. In some cases it may be justifiable to cantilever porches from the building structure.

All of the difficulties cited point to the necessity for care in site selection and for thorough subsurface soil investigation. It has been suggested earlier in this review that some preliminary, and perhaps even extensive, investigations be made prior to final site selection. Actual foundation design starts with a comprehensive study of the subsurface conditions. Each site is an individual problem, and the number of exploratory pits and borings will vary with the conditions found. Some sites require load testing to determine the bearing value of the soil and in many cases this should cover all areas at close intervals because of wide variations encountered. Neglect in this respect has bred an enormous number of construction "extras" where unforeseen conditions required rock excavation or deepened footings.

Steps frequently settle away from the doorsill

Wall Design

Almost every known type of wall has been used in public housing, from monolithic concrete to rammed earth. Metal stud framing is one exception, but this is only because bids taken on such systems proved higher than those for other kinds of walls. Solid brick and concrete-unit walls, tile or other back-up material veneered with brick, and frame walls with various coverings are most commonly found.

All of the masonry wall types, including those with brick veneers, are subject, in some degree, to one or more of the following defects: poor resistance to moisture and leakage, damage from the development of cracks, efflorescence, faulty flashings, and movement of parapets and copings. All of these faults are mentioned in the following paragraphs, but space is too limited for more than a brief discussion. The serious nature of these defects, however, warrants careful and skillful investigation before the design and specification is prepared. The FPHA is continuing its studies and compilation of experience records as in the past.

LEAKY WALLS

One costly lesson learned in low-rent work is the unpredictability of masonry walls with respect to their water- and moisture-resistant qualities. Rain penetration has occurred on projects having wall designs and specifications exactly like near-by weathertight jobs. Even similar buildings on one site behave differently and without apparent reason. Leaks have occurred in walls of most, if not all, designs and in walls of every material. Few weathertight walls seem to have been developed so far. It is usual, and perhaps quite just, to attribute failures to poor workmanship rather than to incorrect design or improper material. Certainly the construction must have competent inspection as well as good design and materials.

Some sections of the country take exceptional buffeting from the weather, for example, the Eastern Seaboard and the Great Lakes area; and walls in these areas merit special consideration. Nevertheless, heavy rains accompanied by high winds may be expected almost anywhere, so that this problem should never be slighted in any location.

> Solid masonry walls (exposed, or waterproofed and plastered direct): This type of exterior wall construction, generally in conjunction with concrete floor slabs, has resulted in excessive condensation on walls, streaking, peeling of paint, and some damage to gypsum plaster. Metal windows and sills rust. Also there is a tendency for the bond between gypsum plaster and the waterproofing coat to loosen, flake or bubble. — Regional Report
>
> Solid brick walls are reported to have fewer leaks than walls with brick backed with tile or block. — Technical Division Report

The three principal factors that dictate whether or not a wall will be free from troubles—or even failures—are design, materials, and workmanship. The last factor has been mentioned as being, possibly, the most important; but since perfect workmanship is always difficult to obtain, the combination of design and materials should be as close to foolproof as can be devised. The FPHA does not feel at this time that its experience is sufficient to warrant any unconditional advice. But some good and weathertight walls have been built in every area where public housing has operated. Every local authority should, therefore, study and investigate its own problems, noting carefully the failures and successes that have been experienced, and make its decisions in light of this information.

> Furr all masonry walls except the cavity type. — Regional Report

CRACKS IN MASONRY WALLS

Cracks in masonry walls have developed from three main causes: unbalanced foundations or their settlement, lintel deflection, and nonuniform movement of walls and of concrete floors. The first two causes are avoided by proper design; but the last is more difficult of solution because many factors, some not well understood, are involved. Large wall openings made by vertical rows of windows, or the varying strength of mortar bonds may contribute to nonuniform movement. The greatest problem lies in floor slabs bearing on walls; consistently these have caused cracks, chiefly at building corners, and no study so far has explained the exact reasons or produced practical remedies. The matter is discussed in somewhat more detail under "Floors".

Cracks appear at building corners

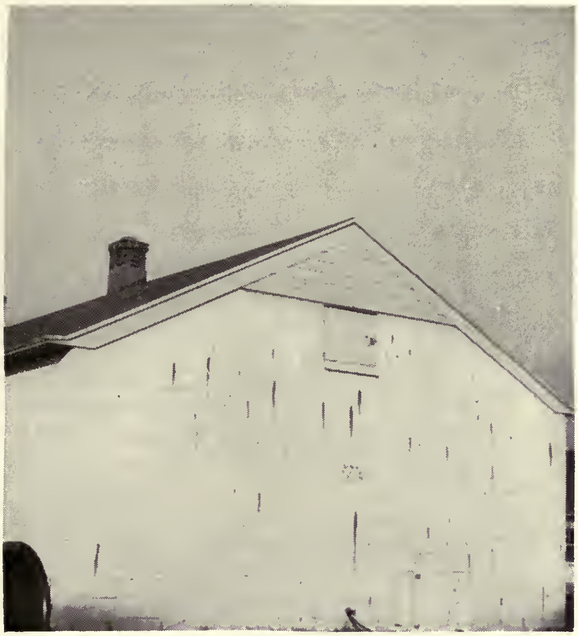
> Buildings are approximately 180 feet in length. Some end walls are cracking at the roof slab line. — North Carolina
>
> Concrete window headers and slabs, on a permanent project, contract and expand to the extent of permitting leakage. This seems to be impractical construction. — Regional Report

EFFLORESCENCE

This is not merely a nuisance item though it is frequently thought of just as that. The visible evidence is a warning not only of poor materials but of dampness caused by improper flashings and faulty walls. The proof of this statement lies in the fact that efflorescence is nearly always noted on parapet walls and below window sills, points at which leakage is most prevalent.

PARAPET WALLS

Parapet walls and copings on low-rent dwellings have caused a lot of trouble. Copings creep on parapets, parapets creep on concrete roofs. In one city the early projects have parapets, but they have been omitted in later buildings because of the continual maintenance they demand. Where local codes require parapets, those with through metal flashings under terra cotta copings have given the best service.



Iron in cinder blocks will stain and streak

> Brick parapet walls to be coped. Vitrified tile with vertical interlocking joints has proved satisfactory. — Regional Report

> On parapet walls we have had considerable trouble because they were constructed of brick. When they are made of reinforced concrete we have no trouble at all. When made of brick they are pushed out at the corners. — Regional Report

FLASHINGS

Wall flashings have been so installed in some cases that they formed a reservoir leaking water on to the floor rather than conducting it outward. In an Eastern project it was necessary to drill several hundred holes in the wall to drain off the accumulation of water dammed up at floor level. Mastic flashing between spandrels and floors forms a plane of weakness and destroys the bond between wall and floors. Flashings had better be omitted than be used improperly.

> Flash over lintels and at base of wall. Through-wall flashing to be turned up at inner face of wall. — Regional Report

> Use pan-type flashing over all openings, turned up at ends and back on inner face of wall, and continuous through-wall flashings at all concrete floor slabs. Flashing to be kept at least two courses above top of slab and turned up on inner face of wall. Provide weep holes at all flashing points. — Regional Report

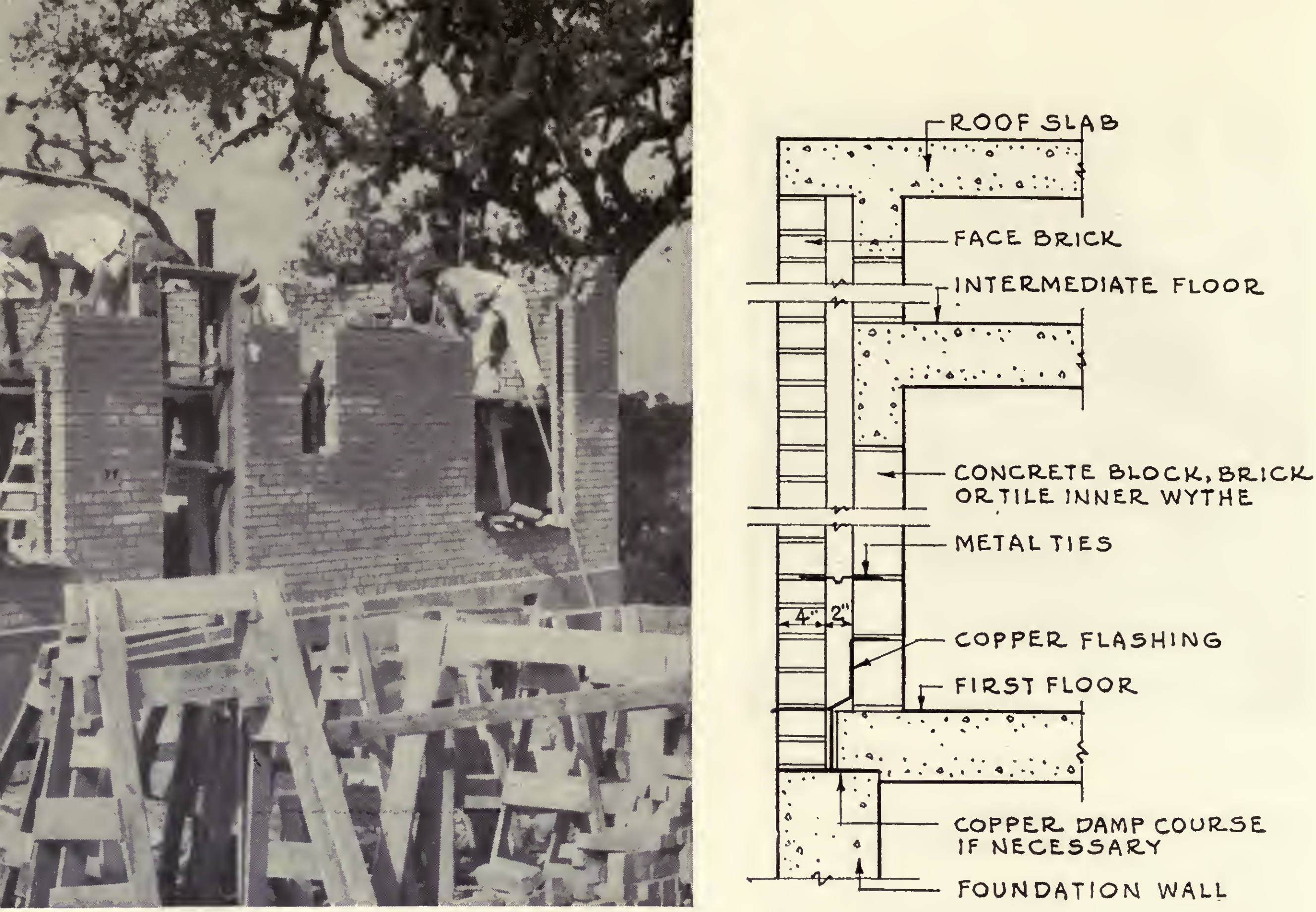
WALL TYPES

Concrete block walls have been widely used throughout the country because of their economy. The block is satisfactory when thoroughly cured and laid dry. If not, even a good cement paint has not made the wall watertight. As a rule, however, a cement paint or stucco coating can be counted on to waterproof the wall; the paint should always be scrubbed on with a stiff brush.

A number of projects have been built of cinder blocks in which the aggregate contained iron or iron oxides. Stains and spalls developed which had to be cut out and patched, with consequent repainting of the whole wall.

Monolithic concrete walls have been used extensively in those parts of California having equable temperatures. Relieving joints have been placed in the walls and temperature reinforcing steel added to both faces.

Monolithic concrete walls have been used successfully in mild climates



Well-built brick cavity walls are economical and waterproof

Brick has been the most common facing material. Very frequently it has been used as a veneer over wood frame construction for relatively low and short buildings. Such walls have proved economical and very satisfactory when carefully detailed; in localities where there is no record of guiding experience this construction should not be attempted without study of successful work of its kind. Balloon framing should be used to avoid shrinkage fracture at floor lines.

Brick is sometimes used for the whole wall, but is more often backed up with tile or concrete blocks (plain, cinder or lightweight aggregate). The size and shape of back-up units vary widely. All sorts of claims and counterclaims are made as to the water-resistant properties of these shapes, and some of these claims seem credible. For example, the vertical-cell tile, notched to receive the bond course, appears to have special merit: but it is noted that some walls utilizing these, as well as all other shapes and sizes, have leaked while others have not.

Brick cavity walls, sometimes with the inner wythe of tile or concrete block, have given good results. They have been used even in three-story buildings by varying the thickness of the inner wythe which carries roof and floor loads, or supported by a reinforced concrete skeleton frame.

A modification of the cavity wall design used on one Eastern Seaboard project is reported to have given good results. Here the water which penetrates the outer wythe runs down the inside face where it is caught in a continuous metal trough and then drained out again through weep holes. Further research in this and other types of cavity walls will be of value.

> The project has cavity walls with skeleton construction. It is two, three and four stories high. It gives less trouble than any other project in the city. — Regional Report

Tile units for the entire wall have been used with varying degrees of success. One of the more popular types in some sections of the country is the so-called "through-wall brick" unit; this is of standard brick size on the face and usually eight inches deep.

Tiles with textured surfaces on the outside, glazed or semi-glazed on the inner face and unplastered, have proved economical in some localities.

Wood frame walls, both balloon and platform, are to be found in low-rent housing, and in some cases balloon framing is carried up two stories with a third story built of platform framing. Regions of high winds, such as Florida and the Gulf Coast, use balloon framing in preference to platform framing because the whole building can be tied to the foundation.

It is not necessary to specify diagonal sheathing in frame buildings over 75 feet long, except on the end walls. Gypsum or fiberboard sheathing should be supplemented by structural bracing at the building corners.

> The rainy climate of this area makes the use of vertical flush siding inadvisable. The boards expand and contract causing the joints to open up badly. — Regional Report

DAMPPROOFING INTERIOR FACE OF WALLS

Masonry walls of low-rent buildings are usually provided with some form of dampproofing unless they are furred. Experience with dampproofing varies considerably. As a rule troweled mastic has been more effective than sprayed mastic, which is subject to air bubbles and pinholes. A Pennsylvania project with tile-faced units has a grout of cement and sand 3/8 inch thick applied on the inside face of its wall. This is entirely successful, although it costs more than mastic dampproofing.

Diagonal sheathing is needed only on the end walls of long buildings

Tile units are used successfully in a large development

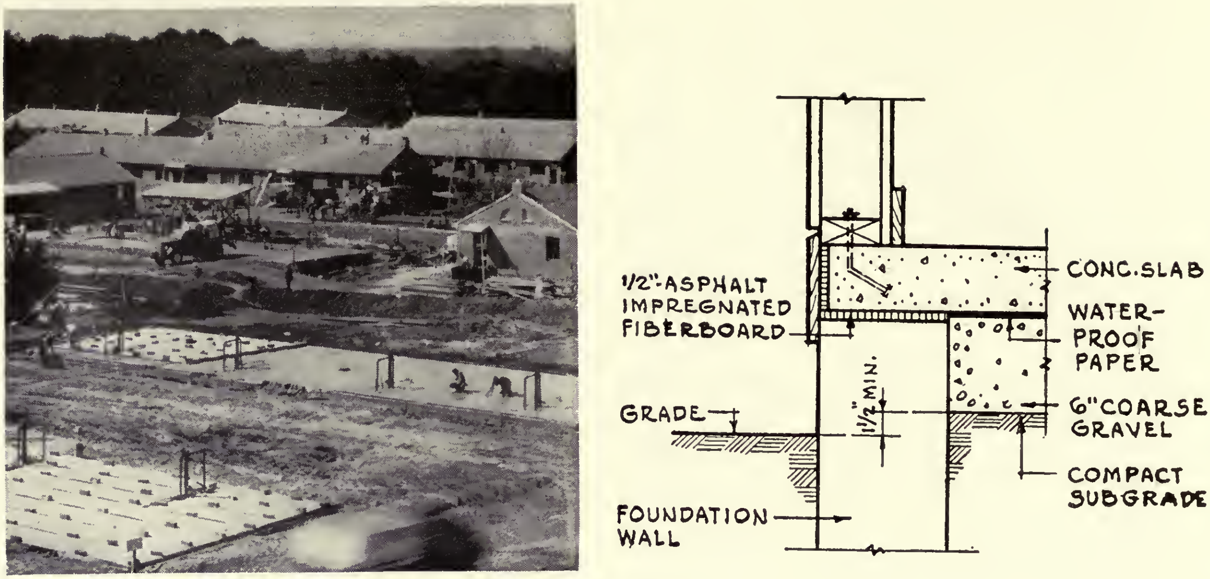
Floor Design

Practically all types of floor construction, fireproof and combustible, have been used in public housing work, but the common ones have been concrete slabs on grade, solid framed concrete slabs, and those of ordinary wood construction.

CONCRETE SLABS ON THE GROUND

The most common type of ground-supported concrete slab is four inches thick, lightly reinforced. This is laid over a prepared subgrade on a layer of coarse slag, stone or gravel placed to resist the capillary rise of moisture. It is well to avoid cinders or sand as a substitute for gravel fill since they are not barriers to capillarity. A layer of tough kraft paper on top of the gravel will prevent the grout from being dissipated into the porous bed.

All basement floors do not need this intensive precaution against dampness. Unoccupied spaces, laundries, and certain types of storage rooms usually can do without the prepared subgrade.



Ground-supported concrete slab is laid over a prepared subgrade

Earth fills required under floor slabs must be carefully prepared to insure uniform bearing and to prevent settlement. Fills up to five feet in depth have been used successfully when laid in thin layers, sprinkled and rolled, but very careful inspection is necessary. When deeper fills are required framed floors are recommended.

> Damp floor slabs — mildewed rugs, shoes, furniture, bedding, insect breeding due to stagnant water; impossible to lay linoleum on a slab over damp crawl space; disintegration of pipe covering, etc. — Regional Report

A porous concrete slab floor has been used in some projects. This slab is six inches thick made of ¼ inch to ⅝ inch aggregate with just enough cement grout added to coat the aggregate. It requires the same precautions against dampness as does the solid slab, and offers no special advantages.

A four-inch base of hard-burned clay tile on a leveled subgrade was used with success in some Southern projects. The tiles are butted close together with adjacent cells at right angles to each other. Concrete is poured over the tiles to a depth of two inches and a troweled finish is added.

FRAMED CONCRETE FLOORS

The use of solid concrete floor slabs has been adopted by many local authorities partly because the ceiling need not be plastered. However, the production of a smooth and satisfactory surface has not always been easy to achieve and some contractors have even claimed that extra costs of form work plus removal of concrete fins, rubbing and otherwise putting the surface into acceptable condition more than offset the cost of the plaster. It has been found essential to prepare the specifications with vigilance; especially as to clearly defined tolerances, so as to avoid excessive bids for this type of work.

The use of plywood forms has proved more satisfactory than metal forms, rust from which has penetrated the concrete and later burned through the ceiling paint. (For the same reason, metal supports for slab reinforcing are galvanized to avoid rust). Plaster applied directly to the solid slab has not proved successful unless the slab first was cleaned and roughened, a bond coat and a finished coat applied, the total plaster depth being not more than ⅜ inch.

> It was recommended that on concrete ceilings primer-sealer should be used and brought to a flat oil finish. Textured oil finish should be discouraged as it fails to hide the joints, requires more paint, has a tendency to loosen and is impossible to clean. — Regional Report
>
> Concrete floors above other apartments have in some cases cracked to such an extent that when the tenant scrubs the floor the water leaks down into the apartment below. — Regional Report

OTHER FLOOR TYPES

Tile concrete joist floors cost about the same to build as framed poured slabs (in some localities they may be cheaper) and give less shrinkage trouble. Floors of metal pans with concrete joists, and also floors made with steel bar joists, have been used less often, since spans common in low-rent work are smaller than the most economical spans for either of these systems. Also the depth of construction of either type, including plaster ceilings, adds slightly to building heights.

Girderless slab floors (mushroom and similar types) have been little used because they are more expensive than other types. Some examples of precast concrete joist floors exist either with precast or with monolithic floor slabs. The monolithic slab bonds better to the precast joist, and does not need mechanical bonds (stirrups or notches); neither does it require such careful workmanship as the precast slab.

RELATION OF FLOOR CONSTRUCTION TO WALL CRACKS

As noted previously, masonry walls have developed many cracks, the most conspicuous of which are those observed at floor and roof lines, chiefly at the corners of buildings. There seems little doubt that there is a close relationship between these cracks and the system of floor construction used. The weight of evidence, though not to be considered conclusive, favors the theory that the solid concrete slab bearing directly on walls is the chief source of the trouble.

Cracks attributed to causes other than settlement occur both in skeleton frame and in wall-bearing structures, and in the short ends as well as the long sides of buildings. Invariably masonry over the crack is projected. This leads to the belief that shrinkage is a more important factor than temperature change. And it has been observed in some projects that after about two years this movement ceases. It is thought that when concrete floors are poured their shrinkage pulls the wall inward; meanwhile, just above the floor line, the buttress action of walls at the corners holds the wall out in its normal position. Reinforcement in the bottom of the floor slab results in unbalanced shrinkage between its top and bottom faces, which gives a tilting action at the walls, particularly at the corners.

The following suggestions are offered as conjectures from the experience so far gained. The study of this problem has not advanced far enough to draw final conclusions:

1. A lean concrete mix for floor slabs (2000# rather than 3000#).
2. Reinforced columns anchored to the floor above and below, and (in bearing walls) at the corners.
3. Shallow continuous reinforced spandrel beams monolithic with the floors. Sometimes half-inch dowels two feet on centers have been put in the tops of these spandrels. If the spandrel is veneered with brick, there should be about an inch between the veneer and the spandrel proper.
4. Transverse relieving joints in floor slabs, not more than 40 feet apart. They are made by a trowel cut in the partly set slab to the depth of the main reinforcing steel. Usually these joints are covered by partitions.
5. Expansion joints in walls over 200 feet long, with corresponding joints in floors and roof. These joints are protected from rain.

CONCRETE FLOOR FINISHES

Cement is the least costly finish for concrete slabs. If the slab is laid using the vacuum process it can be troweled immediately without additional topping. Besides this advantage, the concrete slab is stronger because of the reduced water-cement ratio.

Integral liquid hardeners do little to improve wear resistance: metallic hardeners are necessary

The vacuum process eliminates topping

only for exterior steps and interior stairways.

The most satisfactory mix for cement finish on concrete floors is one part cement, one part sand and about two and one-half parts of aggregate ranging from 1/8 inch to 3/8 inch. Troweling is delayed as long as possible to keep cement and sand from being drawn to the surface, and the finish is carefully cured.

In some cases a good finish has been obtained by dusting a dry mix of one part cement and two parts sand on the screeded slab during the floating process, and steel-troweling it after the dry mixture has drawn enough water from the slab. If it is not spread evenly, however, it shows color and texture variations. Color on or in cement finishes almost always fades or streaks and wears unevenly.

In an effort to overcome the objections to concrete floors, they sometimes have been painted, waxed, treated with integral color, or dyed, but none of these efforts has been altogether successful. Paint soon wears off, wax is costly to maintain, and may even be dangerously slippery. Certain dyes have been disastrous: they have left a sticky coating on the surface of the floor so that rugs were torn apart when lifted.

> Concrete floors unsatisfactory from standpoint of appearance and livability. They crack and are cold and uncomfortable (bad especially for children and elderly persons). The condition is less bad in multiple dwellings where there is adequate constant heat at top and bottom of floors. Even here, however, tenants object to appearance. — Regional Report
>
> Concrete floors — tenants do not complain; no condensation in aided projects. — Regional Report
>
> A good deal of resistance to concrete first and second floors is encountered when the units are rented, but these are accepted by the tenants after occupancy with very little complaint. Where the floors are of wood, there is more management difficulty, since it is hard to prevent the tenants from scrubbing wood floors. — Regional Report
>
> Paint, staining, not so good as asphalt tile for concrete floors. — Regional Report

WOOD FRAMED FLOORS

Wood framed floors are used in projects all over the country, for the most part at a cost somewhat greater than concrete slab floors when the cost of the finished wood flooring is included. Experience in low-rent work has not added to our knowledge

Asphalt tile is preferred to paint or stain on concrete floors

of this conventional system, except that tests have discouraged engineers from relying on cross bridging to transmit concentrated loads from adjacent joists, particularly when the joists are shallow. Fire resistance has been attained in some cases by placing a lean concrete mix between sleepers separating rough and finished floors.

Roof Design

The choice between flat and pitched roofs seems to have depended on a combination of factors: building types, comparative construction and maintenance costs, need for attic space, and appearance. In recent housing authority reports the proponents of pitched roofs are much more vocal than are those of flat roofs; this may or may not have to do with objection to what is termed the "modern" or "functional" style in architecture. The FPHA takes no stand on the matter, but notes some points derived from experience.

> As compared with pitched roofs, we have already experienced considerably higher costs of maintaining the flat roofs. — Virginia
>
> Pitched roofs are preferred but an artistic break by way of flat roofs among them seems desirable. — Maryland
>
> We have had considerable trouble with flat roofs, and further, they detract from the general appearance. — Illinois

FLAT ROOFS

One advantage of the concrete roof slab is its low insurance rate; but neither the effect of standing water as a breeding ground for mosquitoes nor the tendency of such slabs to move in opposition to masonry walls should be overlooked. When steel bar joists are used to combat movement it has been found necessary to ventilate the ceiling under the roof. One Northeastern project, lacking such ventilation, had to deal with damaged ceilings which resulted from ice forming along the inner face of the masonry wall.

As a rule, the concrete slab roof (level, or with a slight pitch) has a center bearing on concrete posts and girders, although occasionally it has been carried on an interior masonry wall.

Rigid insulation board used over concrete slabs has not always been treated against moisture. Without such treatment the insulation material is not sufficiently protected, and disintegration results.

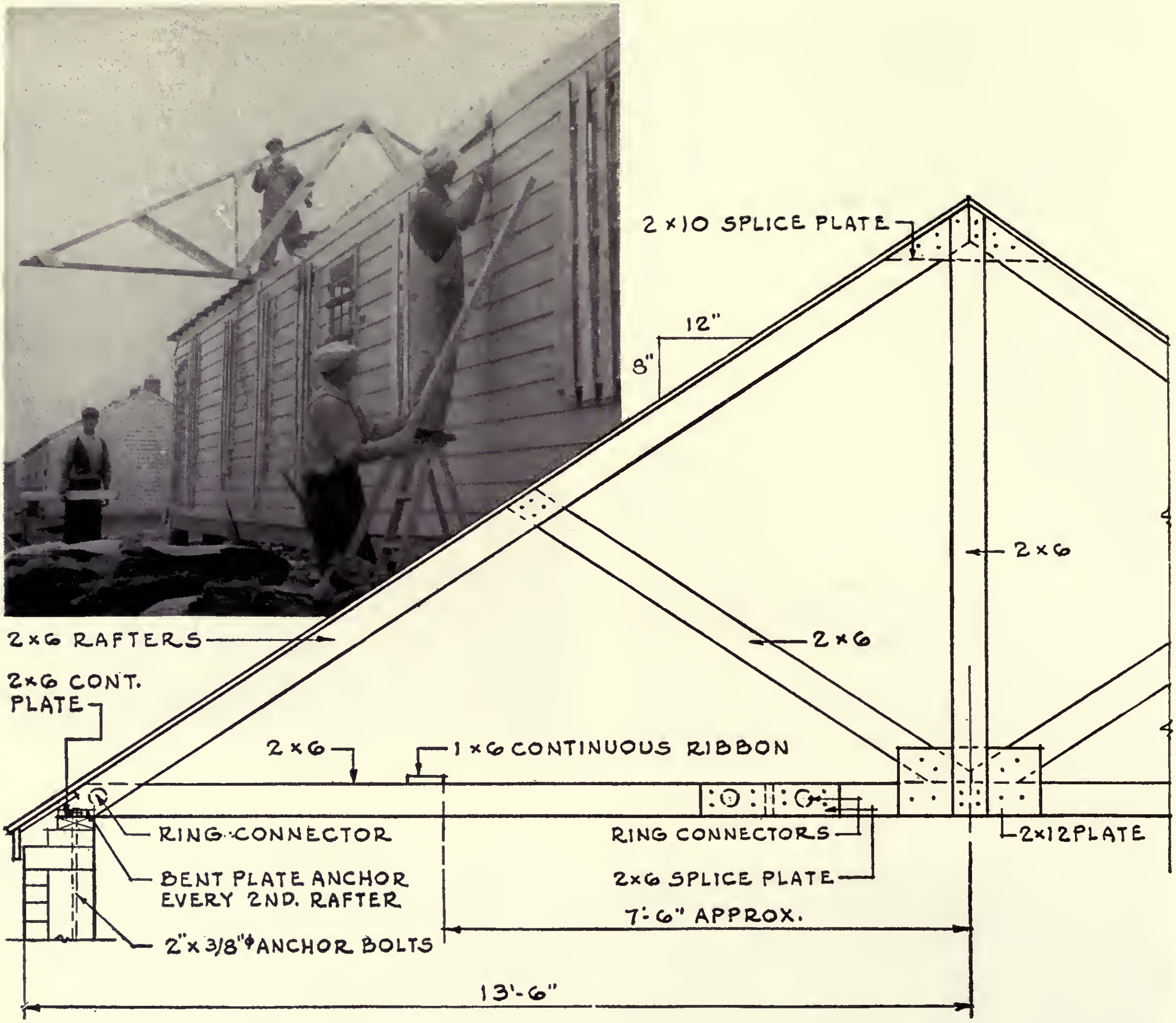
Butted insulation board used on concrete deck

No better finish for flat roofs than the commonly accepted built-up roofing has been discovered. Four-ply roofing usually is adequate for a concrete deck which is covered with butted insulation board (or for shiplapped insulation board on a wood deck) and standard five-ply roofing for other designs. Experience shows that a twenty-year bond is worth the small extra cost.

Where water will stand on a roof—dead level roofs or roofs designed as cooling ponds—coal tar pitch roofing rather than asphalt is needed to avoid the emulsifying action of water with asphalt. Coal tar pitch is not normally available for use on roofs on the Pacific Coast or in the Mountain States, hence asphalt is more generally used; manufacturers in these areas rarely bond such a roof.

> The construction of built-up roofing over flat wood and concrete decks should include interior roof drains and conductors. — Regional Report

Wood joist flat roof construction is usually dead level, although joists are sometimes cut to a slight pitch. This type of roof has been combined with



A lightweight, prefabricated truss is cheaper than rafters

masonry bearing walls and fireproof floors to avoid expansion and shrinkage stresses occurring when concrete slabs are used. In such cases insulation is placed on top of the ceiling with a vapor barrier below it, and ventilation of the space above insulation is provided by means of a series of openings or a continuous slot in the eaves to avoid condensation. This has not worked out well in some instances, especially where the openings are close to the face of wall; snow and rain blow into the roof space during stormy weather. See "Thermal Insulation" below.

The fascia boards covering the roof-vents were not deep enough, and rain drove in. — Pennsylvania

To prevent condensation, ventilate all attic spaces and spaces between roof joists of flat roof construction. — Regional Report

PITCHED ROOFS

Pitched roofs of all types—gable, hip and shed—may be seen in low-rent developments, but the gable roof is the most usual form. Gable roofs provide safe and positive ventilation through their gable ends. They can be made fire-resistant by the use of cement plaster on the soffit of attic joists.

Where attic space is not needed light roof trusses may be substituted for conventional rafter framing. Such trusses, developed during the war, have proved cheaper than rafters for spans up to 24 feet, and are easily made on jig tables. The truss weighs 67 pounds and 85 pounds on spans of 20 and 24 feet, respectively, and has a factor of safety of three and one-half times its design load, namely, 20 pounds per square foot of roof area.

PITCHED ROOF COVERINGS

Cement-asbestos shingles are thought to be the most economical finish for pitched roofs, if first and maintenance costs are calculated. Their manufacture under close control results in a uniform, dependable product. Slate of Grade A (Federal Specification) quality has given good service on low-rent buildings; but its cost is greater than that of cement-asbestos shingles. Slate of inferior grade has not always been satisfactory, both because its brittleness leads to repair bills and because determination of the grade is difficult.

Roofing tile in weights considered cheap enough for low-rent work, like slate, is subject to breakage from workmen's traffic, weather damage and stray balls or stones.

> Roofing finish: Trouble in even moderate winds with shingles (asphalt composition mineral-surfaced 3-tab type). Tab vibrates and eventually whole top blows off roof. One project with expensive asbestos composition shingle roof has given trouble because the shingles blow off even in moderate winds. Composition roll roofing buckles in warm weather. — Regional Report
>
> Roof finish: Shingles lifting — may be due to shrinking and curling of wide sheathing boards. — Pennsylvania
>
> No trouble with shingle roofs in this region. — Regional Report

Wood shingles are not chosen for group housing, except under special circumstances, because of the fire risk involved.

> Tiles look very pretty, but lightweight tiles used are reported unsatisfactory. Much damage done by high winds; they are easily broken when people climb on roof to mend something. Many tiles have had to be replaced. Maintenance of asbestos shingles has been negligible according to management and maintenance supervisor. — Wisconsin

INTERIOR PARTITIONS

Partitions usually have been made of wood studs when wood frame construction or wood floor joists were used, and of tile, gypsum block, or solid plaster —generally the latter—when the construction was of a fire-resistant type. Glazed tile or brick frequently is used around public stair enclosures, and occasionally is warranted elsewhere.

Sound insulation and fire resistance have been objectives, in addition to structural stability and endurance. There have been few if any developments

Partitions between dwellings need sound insulation

of special interest other than the unusual extent to which solid plaster partitions have been used in public housing and the improvements in their design that have resulted largely from this widespread use.

In early housing work this partition was, as a rule, two inches thick, and made of plaster applied to metal lath supported by ¾ inch steel channels spaced 16 inches on center; these studs were secured at floor and at ceiling by metal runners. Changes have been made from time to time which have resulted in improved stability and reduced cost. Among some of these changes, used singly and in combination, are: special runners for securing studs, a combination baseboard and bottom runner, more general use of wood runners, use of gypsum plaster base instead of expanded metal (there are several designs, some patented), reductions in thickness to about 1¾ inches, and greatly improved methods of securing door bucks within openings.

It was thought originally that door bucks should extend from floor to ceiling in order to prevent cracking at door heads. Since then rather extensive tests have indicated that the partitions should be considered as a diaphragm, with the door not a structural part but only an incidental opening. In any event, rapid progress in this field is being made, and it is advisable for designers to keep informed of the latest developments.

Every effort should be made to avoid cracks in partitions. Control of insect pests, by reducing the number of places which harbor them, and the minimizing of cracks where plumbing fixtures are placed (particularly above the bathtub) will aid in promoting sanitation and general cleanliness.

Cleanliness is also promoted by preventing cracks between wall and tub.

Sound Insulation

Satisfactory living conditions require that tenants shall be protected from obtrusive noises created by others. The tenants should be free also to create a reasonable amount of noise in their homes without thereby annoying others. The following outline and the suggestions as to remedial measures should be supplemented by study of more detailed data.

The particular amount of sound reduction required in the "Minimum Physical Standards" is derived from a study of three sources of information; these were included to secure the broadest possible base for an opinion, and because each of the sources did not record information on all types of noise which might be expected in a home.

TABLE I

BASIS OF SOUND-REDUCING REQUIREMENTS

	Loudness levels in decibels		
	Source x	*Source y*	*Source z*
Loud radio	....	....	80+
Average radio	....	65	....
Quiet radio	....	45	....
Soft radio or sound in average residence	35	....	....
Average sound in very quiet room	....	....	30
Quiet conversation	....	25	....
Whisper 4′ away	20	....	....

PLANNING AND SPECIAL CONSTRUCTION ITEMS

Methods which are economically practicable in low-rent work to reduce sound transference are:

1. Designing units as far as possible so that rooms used for similar purposes will be adjacent in adjoining dwelling units in both horizontal and vertical directions. Common noises will tend to blanket each other, and impact noises through floors (usually the most objectionable) will at least be less annoying.
2. Spacing windows as far as possible from windows in adjoining dwelling units.
3. Inserting a sheet or fiberboard fitted tightly to the buck between medicine cabinets which are placed back to back.
4. Insuring that plaster is cut back to clear all pipes passing through dividing partitions. Annular space surrounding the pipe should be stuffed with mineral wool to exclude vermin, and escutcheons should be provided.
5. Selecting equipment which operates quietly. In this way noises from sources under control of the designer are much more effectively and cheaply controlled than by sound-deadening insulation. Preventable sound nuisances are, for example, noisy screen doors and water closets, undersized water pipe runs and sharp bends and fittings.

FLOORS AND PARTITIONS

The sound-reducing characteristics of any floor or partition can be bettered in three principal ways: by a sound-absorbent surface, by increasing the weight of the floor or partition, and by separating the floor or partition into independent layers with a minimum of structural connections between the layers. Partitions built with staggered wood studs will absorb about five decibels more than will conventionally built stud partitions. Felt strips or spring clips between studding and lath will also increase sound absorption in the wall. The use of absorbent surfaces on house walls is not recommended because painting will reduce the absorption, and sound-absorbent finishes are not easily cleaned.

The sound-carrying ability of a floor or partition in the direction parallel to the plane of the floor or partition is decreased if the continuity of the structure is interrupted. Thus, in wood frame buildings, the floors and subfloors should be interrupted at party walls. Such interruptions of the structure are not necessary in concrete frame buildings as the weight and stiffness of the structure is sufficient to prevent annoying transmission of usual air-borne sounds.

The more economical partitions which are shown by tests to meet the requirements of the "Minimum Physical Standards" are listed in the table below:

TABLE II

SOME PARTITIONS WITH SOUND TRANSMISSION LOSS OF 45 DECIBELS OR MORE

Tests Made by The National Bureau of Standards[1]

Panel No.	*BMS No.*	*Panel construction*	*Transmission loss*[2] *frequencies 256–1024*
1	123	Wood studs, fiber lath, gypsum plaster	48
2	125	Staggered wood studs, fiber lath, gypsum plaster	54
3	125	Staggered wood studs, paper-backed wire lath (Ecod), gypsum plaster	51
4	150 151 152 153 167	Wood studs, spring or stiff clips or felt strips under gypsum lath, gypsum plaster.	46 to 52
5	62	8″ tile walls, plastered two sides. (It is assumed that 8″ walls of concrete masonry units, plastered both sides would be equal to the tile partition.)	46
6	79 80 81	8″ brick walls plastered both sides	50 to 51
7	25 26	4″ brick walls plastered both sides	45 to 48
8	—	Staggered wood studs, ¼″ plywood glued on, covering both sides, and ½″ gypsum board nailed over the plywood both sides. (Presumably the plywood and the gypsum board could be reversed in position without much change in transmission loss.)	46

---

[1] Tests on panels 1–7 recorded in Sound Insulation of Wall and Floor Constructions, BMS17. National Bureau of Standards, GPO, 1939.

[2] Decibel figures are to the nearest round number.

The efficiency of any unplastered masonry construction is doubtful unless unusual precautions are taken to prevent any cracks or interstices extending through the wall. Where storage rooms or closets occur along a party wall any special sound-reducing construction can reasonably be omitted.

> Insulation: mandatory between dwellings. Recommend closets on party walls. — Regional Report
>
> Party walls of 4" block reasonably sound-proof, according to manager. — Virginia
>
> This project, with its poured concrete dividing walls, is a happy exception to complaints of sound transmission. — California

Thermal Insulation

The increasing use of insulation in buildings during the last decade is in line with the general increased use of new methods and designs. The use of insulation has, like all changes, brought complications in its train; and the ills that have followed incorrect installations will promote further research in this subject.

The demand for the cleanliness and automatic operation possible only through the use of relatively expensive fuels requires that unnecessary heat losses be minimized, particularly in units with individual heating plants. Higher temperatures on wall and floor surfaces attained by insulation also lower the heating requirements and increase comfort by providing a higher effective temperature in the rooms, so that a somewhat lower air temperature is possible with comfort. This promotes some economy in first cost of heating plants and a large saving in operation.

The practical value of insulation depends on the cost of insulation as well as on its thermal resistance characteristics. Since insulation is always used in combination with other materials of variable thermal-resistance characteristics and variable cost, a careful study of the thermal resistances, vapor permeability and cost characteristics of the materials proposed, both insulating and structural, is essential in order that the designer can compare costs and thermal characteristics of various enclosures under consideration.

The minimum amount of insulation against heat loss which should be included is governed by the "Minimum Physical Standards." The maximum amount which should be included can be determined by balancing the annual payments required to pay for the insulation against the yearly savings in heating cost attained by including the insulation. It is pointless to include insulation against heat loss beyond the point where such installation shows a definite saving.

Criteria governing the amount of insulation which should be used to promote summer comfort can be selected from test records and from past experience. Structures with concrete roofs have been insulated with from one to two inches of rigid insulation. Such installations may be considered successful if we accept lack of complaint as tacit approval.

Metal foil has certain characteristics which must be taken into consideration when used as insulation: first, a large part of the heat is reflected away from the foil, and thus the temperature of the foil itself is much lower than the air in the room which is being insulated; and second, it is a practically perfect vapor barrier in itself. These two characteristics, if not compensated for in the design, can cause a condition in which vapor on the warm side of the foil condenses on the foil.

Metal foil insulation has other characteristics which differ widely from those of fibrous insulation. It has a low heat capacity because of its light weight and it is not affected by humidity or dampness. Its low heat capacity in combination with its reflective characteristics help to make a quick morning temperature pickup possible. Its resistance to dampness is valuable particularly in exposed locations such as under floors. Aluminum foil is seriously attacked by alkalies and therefore must not touch plaster. Also, aluminum foil should not touch the steel structure or enclosure of steel houses, as a definite difference of electric potential exists between steel and aluminum and dampness will cause electrolysis if the two metals come in contact. Metal insulation should be grounded to prevent interference with radio reception.

CONDENSATION WITHIN THE STRUCTURE

In the years which have elapsed since house insulation became common and important commercially numerous instances where damp or wet walls and ceilings have resulted have been reported, and the roll of trouble spots is still increasing.

Not only housing structures but other buildings containing sources of humidity (even buildings constructed very recently) have exhibited signs denoting dampness within the wall structure. Buildings without insulation usually are free from condensation if they are well heated and if the structure is well ventilated; but instances have been noted where condensation occurred in walls providing insulation only through the nature of the wall surface materials. A serious lack of either heat or ventilation can bring about condensation in an uninsulated structure if active sources of humidity are present. The common frame house, uninsulated, usually is free from condensation trouble because the rapid loss of warm air outward through the enclosure carries away humidity rapidly, and the accompanying loss of heat tends to keep the exterior skin of the wall warmed above the dew point.

In discussing condensation it is necessary to differentiate between causes and sources. The cause consists merely in air containing water in the form of vapor (humidity) coming in contact with any object cool enough to lower the temperature of the humid air below its dew point. Some of the sources which contribute to condensation are: concentration of vapor from laundries, kitchens, baths, unvented gas-fired equipment, humidifiers in dwellings, damp basements, or crawl spaces.

The migration of water vapor in a house is usually upward. Diffusion takes place in all directions equally, but in a heated house it is overcome by convection currents and by the fact that an air-water vapor mixture is lighter than air without water vapor.

There is, therefore, apparently no need to design against the movement of water vapor downward in a structure, such as downward from a kitchen to a crawl space, provided air circulation through the floor is prevented. The most critical danger spots for condensation, consequently, are in the walls and ceiling or attic of the structure.

PREVENTION OF CONDENSATION

Condensation will be prevented if one of three measures is adequately applied. Practical difficulties in the application of these preventives may arise and some of these difficulties may be so serious that it will be impossible to apply the remedy in all cases. The three preventives are: first, lowering of the interior humidity to safe levels; second, inserting a vapor-resistant membrane between the source of the humidity and the insulation; and third, an exterior structure highly permeable to water vapor, or with sufficient ventilation on the cold side of the insulation so that the vapor passing through the insulation is exhausted to the exterior before condensing.

That either the first or second method is adequate if properly applied is obvious. That the third method is adequate has been well established by some tests and by the large proportion of old houses with blown-in insulation where trouble has not occurred.

Since it is practically certain that none of these three measures will be applied in a perfect manner, reliance must be placed on a reasonable application of more than one of them. Occasionally it is impossible to apply one of these methods, so that reliance must be placed on the other two methods, or the type of structure involved must be abandoned.

Application of the basic preventive methods noted above may be effected by use of the following measures:

1. Interior humidity is lowered by educating the tenant in the need for ventilation of the living space, by installing non-closing vents opening to the exterior air in living spaces (such as a hood

over a range venting to a chimney) and by venting bathrooms through the roof.

2. The quality of vapor barriers, both as to long life and to low permeability, should be improved over those used heretofore in many cases. The method of installing vapor barriers is open to quite as much improvement as is the quality of the barrier. Also more study is required to determine where and how to install the vapor barrier in order to cut off humidity from basements and crawl spaces, and to prevent leaks to stud spaces at second or other floor lines and at intersecting partitions.
3. Exterior wall construction should provide ventilation of the spaces within the walls. The ventilation of exterior walls must avoid the possibility of entrance of rain water. Some heat loss is unavoidable if walls are ventilated.

Ventilation of attic spaces usually has been accomplished on FPHA projects by a continuous ¾ inch slot at the eave line on both sides of the attic. This has proved satisfactory, as a rule, if care is exercised to keep the slots clear of interference. Better ventilation could be attained by ventilating at the peak of pitched roofs. In areas subject to wind-driven, hard, dry snow ventilation of the attic should be accomplished by permeable construction such as shingle or tile roofs, and not by slots which will admit snow.

There is quite general agreement that damp crawl spaces have contributed very largely to humidity in the dwelling, and instances are numerous where decay of first floor construction has occurred because of dampness from the ground. Another difficulty arising from damp crawl spaces is the diffusion of water vapor upward through the dwelling to the walls and attic causing condensation in cold weather.

Ventilation of crawl spaces and consequent dispersion of water vapor concentrations there may be secured by ventilating ports in the side walls of the crawl space and by venting them through the roof. Recommendations for side-wall ventilation of crawl spaces usually have carried the proviso that the ventilating ports be closed in the winter to avoid excessive cooling of the floors or possible freeze-ups of water pipes. Wintertime, however, is the season when condensation is most to be expected in the walls and ceilings. Ventilating the crawl space in summer is not enough to insure dryness in winter.

The insulation of masonry walls, as commonly done by furring strips or studs under lath and plaster, presents no known hazards from condensation. It is likely that condensation often occurs on the masonry surface in such walls, but the moisture is readily absorbed in most masonry. Such moisture would normally migrate away from the warm side toward the cold side by distillation, finally dispersing into the atmosphere.

When the furred space under the plaster has been filled with insulating material and the vapor barrier omitted trouble has developed. It is possible, but not yet demonstrated, that a masonry wall so insulated could be protected by installing a vapor barrier, or by using fiber insulating lath for the insulation, or by using thicker furring so that the insulation would not touch the cold surface of the brick on which condensation normally would occur. But on the basis of past experience, we can say only that the furred masonry wall, not otherwise insulated, has never given trouble from condensation, while walls with insulated furred space have given trouble.

The use of rigid fiber insulation board over concrete roof decks is common and the adequacy of such construction generally is accepted. Apparently by placing the fiberboard over a mop coat of bitumen, the entrance of vapor to the fiberboard is so nearly prevented that trouble does not develop.

Miscellaneous Details

Windows, doors, stairways, kitchen cabinet work, and incidental trim must be exceedingly simple, sturdy and functional to serve in public housing. Materials and accessories must stand up under use or exposure with minimum maintenance.

A wide range of opinion obtains among architects about appropriate design and materials for windows, doors and screens. There is also, happily, a wide variety of examples for study by housing authorities and their planners. Conclusions drawn from general experience are here summarized.

WINDOWS

At the beginning of the public housing program many different sizes and types of steel and wood sash were used. Later over thirty manufacturers cooperated to provide five steel casement types and seven wood double-hung types which were recommended for use on low-rent work. This standardization lowered manufacturing costs. A random glance at public housing work shows that this saving did not result in monotony.

Windows with small lights are used in some projects to produce a desired pattern, which may justify their use. It should be noted that the higher first cost of small-paned sash is not balanced by the lower cost of replacing the panes. Smaller panes multiply housekeeping and maintenance work—washing, replacing putty and repainting.

Double-hung Windows. Wood double-hung windows have given good service and are fairly foolproof. They no longer require the old-fashioned, expensive box frames with cords, pulleys and weights; but careful choice should be made among the new devices offered.

Steel double-hung sash of good quality has been found, as a rule, too expensive for low-rent housing.

> Double-hung windows: This type of window has proved to be the most satisfactory type from the standpoint of low maintenance cost and the application of storm sash. Its use is recommended. — Regional Report
>
> Double-hung metal, friction type or pullman type windows are desired in place of casements. This will mean less breakage of panes due to slamming of windows by wind; only one side of sash will be exposed to weather; more satisfactory ventilation. — Georgia
>
> Management likes the double-hung windows as compared with metal casements, for the maintenance problem on both sash and window shades is so very small. — California

Casement Windows. Steel casements in public housing developments usually are of the lightweight "housing type." The advantages of the casement are: full opening to air and sunlight, ease of cleaning, standardization of sizes and details, simplicity of screening. On the other hand, the lightweight steel casement warps easily; it invites condensation; it is a possible hazard to young children; storm sash cannot be applied easily; undersill operators—accepted as the most convenient fittings—need frequent repair.

Wood casements have most of the disadvantages of steel ones and, further, they cost more than do "housing type" steel casements.

> Metal Casement Windows: This type of window has proved to be costly to maintain. Application of storm sash is difficult and costly. Unless equipped with ventilating hopper, ventilation during inclement weather is impracticable. — Regional Report
>
> Condensation: On steel sash high, especially in winter with frosted windows. Probably one reason is that windows start too far from ceiling and top part does not open. — New York
>
> Outswinging first floor steel casements have proved a hazard to running children. — California
>
> A convex ridge to catch water condensation on steel sill worked better than a concave ridge. — Connecticut

Casement windows can be cleaned readily when extension hinges are provided

Steel casements without sill openers; impossible to adjust windows satisfactorily in cold and windy weather. All windows were tight shut and water poured onto sills from condensation. — Pennsylvania

Sliding Sash. Horizontal sliding sash seldom have been used in permanent public housing. They were used extensively in dormitory buildings during the War, largely because of their low cost and simplicity of hardware; and no difficulties other than sticking have been reported. There are possibilities for more general use of this type of window.

Sliding steel sash, satisfactory. Occasionally have to replace steel spring counterbalance. — North Carolina

Horizontally sliding windows stick, but no leakage. Large glass area makes heating and curtaining expensive. — Pennsylvania

Aluminum Sash. It is expected that lower costs will make aluminum windows generally feasible for housing projects. They have been used successfully on one Southern project. Aluminum window sills have given good service on many public developments since the early days of the program. Aluminum frames may lend themselves better to double-hung sash than to casements: in any case, skill in their design is necessary. The possibility of corrosion from local atmospheric conditions should be considered.

DOORS

Wherever there are children, entrance doors get heavy wear, and in public housing they must be so designed as to retain their fit under this use.

One finds in these doorways just the quality of direct and winning simplicity, that expressive and unforced use of materials . . . — New York

Exterior doors badly fitted and leaked. Heavier saddle improved sill condition. — Pennsylvania

Small projections acting as front entrance roofs fail to prevent rain from blowing under door, thereby ruining rugs. — Tennessee

Space between rear door and screen door should be widened to allow depositing of milk bottles. This space used regularly for deliveries and should be four inches instead of three. — Regional Report

WEATHERSTRIPPING

There are arguments for and against the use of weatherstripping.

Spring metal weatherstripping not fitted well or has shrunk. Serious complaints. Maintenance man wants storm doors or vestibule. — Connecticut

On rainy days water will drive in around all edges of an unprotected door

Front and rear door on certain units have no drip at sill and no overhead protection, consequently rain drives in on floor. Tenants have to protect carpets during rain. Door should be weatherstripped. — Illinois

SCREENS

Sash and door screens are essential in most parts of the country. Usually the saving in first cost realized by half window screens has not been justified, as maintenance costs soon wipe out that saving. Screen doors are fertile sources of repair expense if they are not sturdily built and provided with protective panels.

Half screens don't slide well, are flimsy and break apart at corners. — Virginia

Managers claim screens are not needed. Housing authority reports several accidents and one near miracle: a child fell out of a fifth story window and was caught by a passing project engineer. — New York

We should also like to see a foolproof screen door, probably of light metal, used. Ordinary screen doors will not stand the punching of low-income families with children. — Tennessee

Combination storm and screen door should be given consideration. It eliminates drafts and heating costs. Management does not have to remove and install every year. — Regional Report

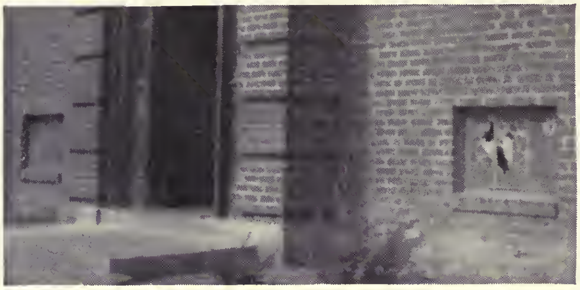
Head stiles on combination screen and storm doors too light. If glass or screen panel were smaller or placed lower in doors, or door contained less wood at bottom or center, or was more substantial at top, many repairs would be avoided. — New York

Screen Doors: Always expensive to maintain as with any out-swinging door. Most satisfactory solution so far is a chain stop-bolted completely through the screen door. Not final solution. — Regional Report

Unprotected basement windows always attract baseballs and rocks.

A protective mesh should be put on all basement windows. — Regional Report

Basement windows need wire mesh protection



STAIRWAYS

Where fire resistance is not a factor, as in row houses of ordinary construction, wood stairways generally are used. If these are designed for shop-fabrication they will be less expensive than if assembled on the job.

Concrete stairs are competitive in price with cast-iron or steel if the structural system is adapted to their use. Cast-iron stairs with steel strings frequently have been used, as have steel stairs with pan treads filled with concrete or other plastic materials. Several new designs for metal stairways have appeared on the market. These may prove economical and durable, but the noise factor should be considered in connection with all metal stairs. Metal nosings and abrasive treads are necessary for public stairs.

The importance of stairway design for safety and convenience is discussed in "The Dwelling Plan."

CABINET WORK

Cabinet work generally is limited to wall and base cabinets in the kitchen, with occasional provision of broom and ironing board closets. Limited space demands that the utmost in utility and convenience be provided at the least cost consistent with durability.

Clever design and arrangement can offset limited area; good appearance is a factor, but the object is not to emulate the elaborate kitchens illustrated in brilliantly colored advertisements. Compactness, adequacy of space, and usability of each part for its intended purpose, combined with clean and straightforward detailing, are sure to produce satisfaction in operation and pleasure in appearance.

Wood, both solid and plywood, are the materials most used. Metal has been used and is nearly competitive in price; comparative costs should be investigated; but the tendency of metal to corrode and the expense of repainting should be considered. The use of doors should be limited: they are expensive, their hardware is a maintenance item, and they encourage untidiness. Glass doors should never be used.

Shelving and hook strips should be well worked out in detail; these items occasionally appear to have been afterthoughts designed with little regard for their precise use.

TRIM AND MILLWORK

Baseboards, door and window trim, and similar items have, on the whole, been well detailed in public housing projects. Their chief characteristics are thinness of line, simplicity of form, ease of cleaning, and durability.

Metal door bucks generally are used in all but wood stud partitions: metal jambs, heads and stools have been satisfactory with metal windows. In wood stud partitions, wood door casings frequently serve as both frame and trim. Metal baseboards have had wide and successful use. In general trim is either flush with the plaster or projects only slightly. Molded work is limited to bullnose and cove forms.

Exterior millwork, including door and window trim, porch work, eave and gable finish, and other similar items, should be used only where essential to utility and appropriate architectural effect. It should be of durable material not subject to decay, and suitable for holding paint: the detailing should be simple but sturdy, and care should be used in joining. Excessive cost of repair and repainting has been noted on many projects where these rules have not been followed.

> Entrances: Front porches with diagonally set, latticed steel supports "wholly delightful." — New York
>
> An adequate brace for lattice awnings could be made not coming down to the porch. Those which come down to porch form a ladder for climbing to the top of buildings. — Texas

HARDWARE

Special attention should be given to provision for hardware: locks, butts, window shade and curtain-rod hangers, and so forth; flimsiness in these has been a source of repair and replacement expense.

Any failure in hardware is not only a replacement item but also results in need for repairs to the fabric of the building itself—broken window glass, ripped screen doors, dented walls. Bronze hardware (except for cast iron and steel in large or concealed items, such as hinges, brackets and the bodies of door closers) gives the least trouble. Glass and plastic knobs need care in their selection. Improperly annealed glass knobs have fractured, badly cutting the user's hand. Some plastic knobs have warped and discolored.

> The hardware is atrocious. Nearly all the front door locks have broken inside the barrel; the glass interior knobs come off. — Pennsylvania
>
> Hardware: Cheap quality doubles its original cost in repairs and replacement. — Managers' Conference Report
>
> Special rather than standard hardware results in difficulty in repair and replacement. — Regional Report
>
> Hardware: No problems reported as to quality. Principal problem is lack of standardization, since every contractor used a different type of hardware. This results in increased maintenance costs. — Wisconsin
>
> There should also be standardization of parts, materials and sizes. — Regional Report
>
> Nickel or glass door knobs used in place of bronze, which tarnish. — Regional Report

Screen door hardware has been a constant source of maintenance expense. Small springs and pneumatic check closers are cheap in first cost; but, as a rule, they bring with them future repair bills. The common lever handle often is not strong enough to stand the use it receives in low-rent work. In many cases chain stops have not prevented the door from being blown back, splitting the stile from top to bottom. The most practical equipment appears to be plain pull handles or knobs, common zinc-coated helical springs at the top, zinc-coated hook and eye fasteners, and a heavy chain stop, its stout spring equipped with a limit stop, placed at the top rail.

Screen door hardware must be strong enough to withstand hard use

> Front doors: leaked cold air, particularly at sill. Storm sash put on screen doors, but cheap latches in many cases failed to hold. 40-50 percent of doors blown off their hinges. — FWA Report
>
> Head rails on combination screen and storm door too light. Heavy spring with rubber ratchet for screen doors. — Regional Report
>
> Due to inferior hardware used for check stops for screen doors they are a constant maintenance problem. — Regional Report

There is practically no difference in cost, on good-sized developments, between rim and mortised locks; and even if the cost of rim locks in a small project should prove less than that of mortised locks, their appearance and their invitation to the experimental child makes them a dubious choice.

Some projects have separate master key systems for each building and for service spaces, such as boiler rooms and janitors' closets; others have a grand master key for all cylinder locks on the project. Managers occasionally prefer to have several spare cylinders keyed alike for installation on vacant units, issuing individual keys to workmen for specific dwellings. An emergency key to open bathroom doors from the outside will save wear and tear on maintenance men, ladders, and frightened children. The arguments for and against self-locking mechanism on outside doors have not yet been resolved.

> The use of push-button stop works in the face plate of apartment entrance door locks should be discontinued or rendered inoperative, and thereby prevent any accidental lockouts. — Regional Report

> Dead lock and knob latch or similar combination for entrance doors to preclude lockouts by tenants. — Georgia

> The type of front door hardware which requires the use of a key to lock is undesirable, first because of inconvenience, and second, because doors are constantly slammed with the bolt protruding, which results in heavy breakage and replacements. — Regional Report

As a rule, less trouble is caused by hardware used in double-hung sash than by casement hardware, obviously because so much of it is out of the way. Some lightweight substitutes for sash balances used during the war period, however, have not been equal to their job.

> Window construction: double-hung with spiral balances. No trouble with either balance or condensation. — FWA Report

> The spring window holders, while disliked, have not given as much trouble as expected. — Pennsylvania

> With steel casements use venetian blinds — cloth shades flap. — Regional Report

> Door bumpers: wooden type provided was a mistake. A child steps on one and it is gone — should be metal with screw plate. — Wisconsin

Hardware and related items illustrate the principle so often observed in the design of low-rent dwellings: the original idea may be excellent, but in the choice of materials or arrangement the last refinement which makes the idea click is sometimes omitted.

> House numbers throughout are of brass, screwed to the lockrail of the front doors. They are crude in design, large, legible in the daylight when the doors are closed, but if the doors are open (as often in summer) they cannot be seen, and there is no method of lighting them adequately at night. — New York

> Mail boxes were badly placed. They have suffered severely from rust, children and furniture moving. They should be above the reach of small children and have at least a hood for protection. — Pennsylvania

TERMITE CONTROL

Reports of termite infestation have come from a few low-rent developments. In areas where termites are known to exist the usual practice has been to guard against them by using metal pans on foundation walls and piers and, in some cases, by treating the wood framing and floors over crawl spaces with an impregnation of coal tar creosote.

A project in Tennessee experienced some termite infestation. This condition was caught before it resulted in damage to the frame buildings. In this case the crawl spaces were very damp, had not been cleared of wood debris, and no precautionary measure against termites had been taken.

A project in Maryland became so infested that parts of the first floor and the supporting sills and girders were completely eaten away and had to be replaced. The buildings were erected in a recently cleared heavily wooded area which was infested with swarms of termites. Tree stumps and wood debris had not been removed from the crawl spaces.

TOXIC TREATMENT OF WOOD

Toxic treatment of wood doors, sash and frames by means of immersion, before painting, in a bath of petroleum solvent and chlorinated phenols has proved generally successful. It is believed to make sapwood resistant to rot and blue stain. Water repellant added to the toxic bath retards swelling, sticking and leakage.

Sill destroyed by termites

Surface Finishes

PLASTER

The arguments against plaster are familiar: Its use brings enormous quantities of water into the building, thus retarding the painting processes and general drying out; plaster will crack, and even, if badly done, fall off. But the fire resistance of plaster, its sanitary qualities, and the amenity afforded by its smooth and unbroken surface, are advantages not to be discarded lightly.

Both metal and gypsum plaster base have given entire satisfaction. The use of corner beads and cornerites, for protection against marring and cracking, is advocated. The point is mentioned elsewhere in this review but is worth repeating here: special precaution should be taken where plaster abuts a fixture, particularly the tub. Hard plaster, such as Keene's cement, is urged for use on kitchen and bathroom walls, and at other places where rough treatment may be expected.

In some cases, the white coat has been left unpainted at the time of initial occupancy with the thought that the walls could stand for a year or two unpainted, or that tenants could do the painting; this, also, has not been entirely successful.

> One manager suggests leave paint off at start. Use oil after six to eight months. — South Carolina

Sand-finished plaster, in natural shades or with integral color added, has been used to eliminate the cost of original and subsequent painting, but has many disadvantages. It has been found easy to mar, hard to patch and somewhat of a hazard to young children.

> Prohibit the use of sand-finished plaster. — New York

> Sand finish in bathroom is of course disentegrating, and tenants complain that the tub bottom and theirs get full of sand. — Pennsylvania

> Plaster with hard white finish is recommended. Sand-finished and tinted plasters are not satisfactory for this type of work. — Regional Report

> Wall finish: Sand-finished plaster is bad, and should under no circumstances be used in kitchens or bathrooms. — Regional Report

> Wall finish: Sand-finished plaster can be O.K. (one project is successful) but, in general, hard-finished plaster is preferable, especially in bathrooms and kitchens. — Regional Report

PLASTER SUBSTITUTES

Plaster substitutes, such as gypsum and composition board, while extensively employed in temporary war housing, have been used only on rare occasions in the permanent program and have not been used long enough to determine their real qualities.

Doubtless great advances will be made in the so-called "dry wall" materials; the arguments in favor of such construction have much merit. Hence local authorities should be alert to all developments that offer savings in first and operating costs, combined with equal or greater desirability; but they should also realize that a low-rent public housing project cannot afford the risk of doubtful experiments.

"Dry wall" materials should be detailed with care

Smooth tile walls finished with paint are attractive and serviceable

A few projects, generally those seeking to keep down costs where very low rents were essential, have used unplastered walls and partitions; matt-surfaced tile, unpainted; or smooth tile or concrete block, painted; all of these, under the circumstances, have been satisfactory.

PAINT

Designers of public housing have discovered no new preparations to end the search for perfect surface finishes. Rather, time-proved applications—red lead for ferrous metals, cement on masonry walls, lead and oil on wood—are those which have given the most satisfaction in low-rent housing. However, the relation of labor costs to that of materials is more apparent in long-term rented dwellings than in private work, since from the first brushful on the wall the surface finish becomes a maintenance affair.

Untreated wood wastes away about one-quarter of an inch in a century. It would be cheaper to replace, say, ordinary bevel siding every thirty years or so than to repaint it periodically. But mud stains, finger marks and chalk designs would then become part of the fabric instead of being removable.

> Even with appearance as a secondary criterion, if the project becomes ugly because of a shabby exterior, painting might well be justified though physical protection is not involved. — Regional Report

> A good grade of oil paint should be written into construction specifications. — Regional Report

Exterior Paint. Many proprietary paints have been used successfully for coating masonry walls. The most reliable and practical finish in FPHA experience is obtained by two coats of a grout composed of equal parts (by volume) of water, sand and portland cement, to which is sometimes added not more than five percent of lime-proof coloring matter. The grout is scrubbed on with a stiff bristle scrubbing brush. After weathering a year or more, the surface has sometimes been painted with ordinary house paint.

Any good paint will stand up on almost any wood for a couple of years. After that time the difference between woods determines the rate of deterioration. Although the difference between the paint-retaining qualities of wood normally used in low-rent buildings is not significant enough to warrant selection on this basis alone, those qualities are classified below:

1. Most satisfactory for all paints: cedars, cypress, redwood.
2. Equally satisfactory for white lead compounds: northern and western white pine, sugar pine.
3. Less satisfactory: fir, hemlock, ponderosa and lodgepole pine, and spruce.
4. Poor in paint-retaining quality: douglas fir, western larch, Norway and southern pine, tamarack.

Proprietary Paints. A lesson learned in the rapid war housing days is that ready-mixed paint cannot do more than its compounds allow. For example, on one project a mixed-pigment paint was used in dark colors, disregarding a specification note indicating that it should be used for white only. After six months the pigments chalked, as was to be expected, with resultant dirty-gray walls.

Flame-retardent paints have not yet proved effective enough under test to be recommended for low-rent developments. Some experience during the war, however, points toward weather-resistant and lasting paints of this kind for the future.

Interior Paint. Casein and resin-emulsion paints have raised a large crop of imprecations. It is true that a plaster wall should be quite dry before it is covered with an oil-base paint. Nevertheless the water-base paints are disliked by management and tenant.

> Oil paint wanted instead of resin-emulsion or casein. — Regional Report

> The resin-emulsion paint is disliked. It cannot be washed, and since management has not been given sufficient money for repainting, some of the conditions are deplorable. — Pennsylvania

Exterior painting helps to make masonry walls impervious

The kitchen needs oil paint, especially behind the range

Flat oil paint used for all interiors, stands up exceptionally well, but gloss for kitchen and bath, semi-gloss for rest of house, suggested in future projects, for washability. — Regional Report

Finish all trim (both metal and wood) with a good grade of enamel. — Regional Report

Kitchen should have oil paint, especially around stove. — Connecticut

FLOOR COVERINGS

Increasing use of asphalt tile, wood or other applied surfaces on concrete floor slabs after the project has been occupied, as well as on new work, has been noted; but the added cost of such surfacings should be carefully considered before deciding to use them. Their undoubted amenity must be weighed against other features competing within a limited budget.

> When concrete floors are covered with asphalt tile complaints cease. — Regional Report
>
> All concrete floors to be covered with asphalt tile. — Regional Report

Wood floors are preferred by tenants and usually also by managers in spite of their complaint that tenants persist in scouring practices that injure the surface.

FPHA's experience shows that uncovered concrete floors produce a combination of economy and dissatisfaction. FPHA's conclusion is: bare concrete floors are justifiable on the score of economy; if ingenuity and compensating economies elsewhere make it possible, they should be covered.

Tenants prefer wood floors

Selection of Utilities

THE selection of utilities affects every other phase of project development—site selection, choice of dwelling types, dwelling unit planning, details of construction, site planning, and site engineering.

The proper or improper selection of utilities can spell the difference between success and failure in the economic operation of a project. The reason is that the choice of utilities affects both the amount which the tenant pays, directly or indirectly, for lighting, refrigeration, cooking, heating, and hot water and the subsidy required of Federal and local governments.

The selection of utilities for lighting, refrigeration, cooking, domestic water, and space heating is determined by (1) making an analysis of the services available to the systems and equipment suited to the specific project, and (2) concurrent negotiations as to the rates and conditions of utility contracts.

On the whole, local authorities have grasped the significance of this problem, and have reached satisfactory solutions, though some errors of judgment, and even of technical calculation, have been made. The following brief statement of the problem and how it may be met is presented merely as an outline and a check list of the major items involved.

Utility Analysis

The final selection of utilities usually should result in the lowest economic expense (operating expense and debt service charges) consistent with livability. Comparable factors for different types of systems and combinations should be used to establish a fair basis on which to evaluate various practicable combinations of utilities for a given project. Because of the technical considerations involved, it is important that the economic analysis be prepared by technicians familiar with low-rent housing. The analysis is divided into four steps (1) consumption estimates, (2) cost study of lighting, refrigeration and cooking, (3) cost study of space and domestic water heating, and (4) summary of the studies (2) and (3) to show the comparative initial cost and economic expense for each of the possible combinations.

ELEMENTS OF THE ANALYSIS

Initial costs of the systems required for each of the various types of utility services should be compared so as to keep the capital cost of the project at the lowest possible level consistent with economy in operation. Initial cost determines the choice between two types of utility services when these show approximately equal operating expense.

The initial costs of various services are made up of the costs of interior and exterior distribution systems, equipment meters, lighting fixtures, and so on. The following items are among those dependent on or related to the utilities chosen and affect the capital cost of the project; hence they should be included in the analysis:

1. Dwelling structure costs above normal incidental to the specific types of heating systems and other services under consideration—for example, the cost of fire protection.
2. Water heaters, hot-water piping, and other related plumbing work, as affected by the utilities under consideration.
3. Chimneys and gas vents.
4. Facilities for fuel storage and additional facilities for fuel delivery and other items in the site plan affected by the utilities proposed.

It will be found advisable to separate the capital costs of certain items into two categories. The basic cost of a gas piping system, for example, should be included in the cost study of lighting, refrigeration and cooking: the additional cost of piping for heating and hot-water equipment included in the cost study of space and domestic water heating. Similarly, the basic electric system should be included in the study of lighting, refrigeration and cooking, and the additional wiring required for heating equipment should be included in the space and domestic water heating study.

The initial cost figures should represent average costs for furnishing and installing the system or equipment, with necessary adjustments and testing, and servicing guarantees which may be required.

Economic expense items for the cost study of lighting, refrigeration and cooking are as follows:

1. Repairs, maintenance and replacements
2. Fuel and energy
3. Metering
4. Vacancy and collection losses
5. Debt service

Economic expense items for the cost study of space and domestic water heating are as follows:

1. Repairs, maintenance and replacements
2. Fuel
3. Electric consumption
4. Operating labor
5. Ash removal
6. Vacancy and collection losses
7. Debt service

The economic expense for the utility combination selected is not for use in establishing final rents.

REPAIRS, MAINTENANCE AND REPLACEMENTS

The annual expense for repairs, maintenance and replacements is computed by multiplying the initial cost by established factors, as developed by experience. In such computations, repairs and maintenance are kept separate from replacements.

The amount to be included for repairs and maintenance should be the estimated annual expense averaged over the life of the equipment. The amount to be included for replacements should be the level amount (annual) to be credited to reserve which, together with the interest compounded annually on the amount held in reserve, will produce a capital amount sufficient to replace the various items so covered at the end of their estimated useful life.

The amount for repairs and maintenance should be carefully checked in the light of local experience, wage rates, and so forth. In this connection, the possibility of having the utility company supply, repair, maintain, and insure the exterior distribution system in whole or in part, or any equipment (such as ranges, heaters and refrigerators) should be investigated; co-operation of this kind has resulted in reduced operating expense to the project.

FUEL AND ENERGY

Costs of fuel and energy should be based on the average consumptions most likely to occur under the contemplated conditions. They consist, in general, of the following items:

1. Quantity charges based on consumptions by tenants.
2. Demand charges based on maximum consumption per stipulated time unit. This usually applies to wholesale purchase.
3. Minimum charges based on estimated demand and consumption.
4. Expense of electric line and transformer losses. This usually applies to wholesale purchase.
5. Prorated expense of fuel or energy consumed for project services: yard and play area lighting; lighting of public spaces in buildings; fuel or energy for central laundries; power for electrically driven units. The local municipality usually provides, maintains and supplies the electricity for all lighting on project streets and other areas used by the public as a part of its usual municipal service, without charge to the project.
6. Fuel or energy consumed for space and domestic water heating.

In the case of heating plants (whether project or tenant operated) employing electrically driven units, the cost of electric power for such purpose should be included in the heating and domestic hot water analysis, based on the average cost per kilowatt hour arrived at by the application of the proper rate to the total load.

To figure the cost of consumption and the average rate when gas is contemplated for (1) cooking, (2) cooking and refrigeration, or (3) cooking, refrigeration and domestic water heating, it is only necessary to estimate an average monthly consumption by applying thereto the extended rates; for estimating purposes the consumption for the above functions is approximately equal each month. When gas is included for space heating it is well to figure the rate averaged over the year, taking the estimated consumption month by month, including all functions, applying thereto the extended rates. The average rate so computed multiplied by the consumption of (1) cooking or cooking and refrigeration and (2) water heating or water heating and space heating will give the breakdown costs for the particular set of functions. The costs for items under (2) should be incorporated in the heating and hot water analysis.

The cost of ice and of coal, kerosene, butane, propane or any other fuel locally available should be given consideration for appropriate uses in the analysis of comparative costs. Fuel prices and methods of purchasing, distributing and storing require careful investigation. It is suggested that in investigating bulk fuel costs, the following wholesale purchasing methods be checked to determine which is most suitable for the specific locality in question:

1. For project-operated plants—wholesale unit quotation based on estimated annual consumption.
2. For tenant-operated plants—a wholesale unit price with a definite commitment based on the estimated total annual consumption for the project. The project is billed by the fuel dealer and the management collects individual payments from tenants. The management arranges periodic deliveries for distribution to tenants, guaranteeing to the dealer not less than truckload quantities.
3. Purchase method similar to (2), except that tenant makes direct payment to dealer.

If fuel which requires storage and handling is considered, the expense of handling should be included in the operating expense.

METERING

In the case of retail purchase of fuel and energy, where individual meters are supplied by the utility company, the cost of meters is not a factor of initial cost, and there is no expense to the project for repairs or reading and billing.

Check meters are usually desirable with wholesale purchase of fuel or energy. There are several factors, however, which influence the necessity for such installation. For example:

1. If heat and hot water are project-supplied and low-cost gas is used for cooking only, it does not pay, as a rule, to install a typical metering arrangement.
2. If gas is used for space heating and water heating in addition to cooking, it is advisable to install check meters.
3. If the tenant provides his own fuel for space heating and the project provides gas for cooking, check meters should be installed, as the tenant may use the range to provide space heat.

In cases where it is doubtful whether or not meters should be installed, facilities for their possible future installation should be provided and the need for meters decided on after the project is in operation.

In the case of wholesale purchase of fuel or energy, if it is determined that the project should install check meters, their cost—together with the expense of reading and billing, repairing, maintaining and replacing—should be included in the analysis of lighting, refrigeration and cooking.

OPERATING LABOR

In estimating labor costs, it is advisable to formulate tentative operating schedules for the proposed schemes. The schedules should conform to local regulations and requirements.

VACANCY AND COLLECTION LOSSES

When vacancies occur project expenses continue substantially undiminished. Therefore a sum should be applied as a reserve for vacancy and collection losses on the annual expense of such utility services as are supplied by the project.

DEBT SERVICE

Debt service, which includes interest and amortization, reflects initial cost.

MISCELLANEOUS

The cost of such items as oil, water, tools, wheelbarrows, and waste for project plants should be included.

SUMMARY OF COMBINATIONS

In summarizing the various combinations of utilities usually only such combinations of lighting, refrigeration and cooking as are practicable to combine with certain combinations of space and domestic water heating should be included. All utility comparisons should be based on the final summary. In summarizing, the cost of individual functions should not be compared.

Utility Rate Negotiations

Conferences should be held with the local utility companies before the preparation of the utility analysis to ascertain their facilities for supplying the project.

METHODS OF PURCHASE (FUEL OR ENERGY)

Gas or electricity may be purchased from a utility company by any of the following methods.

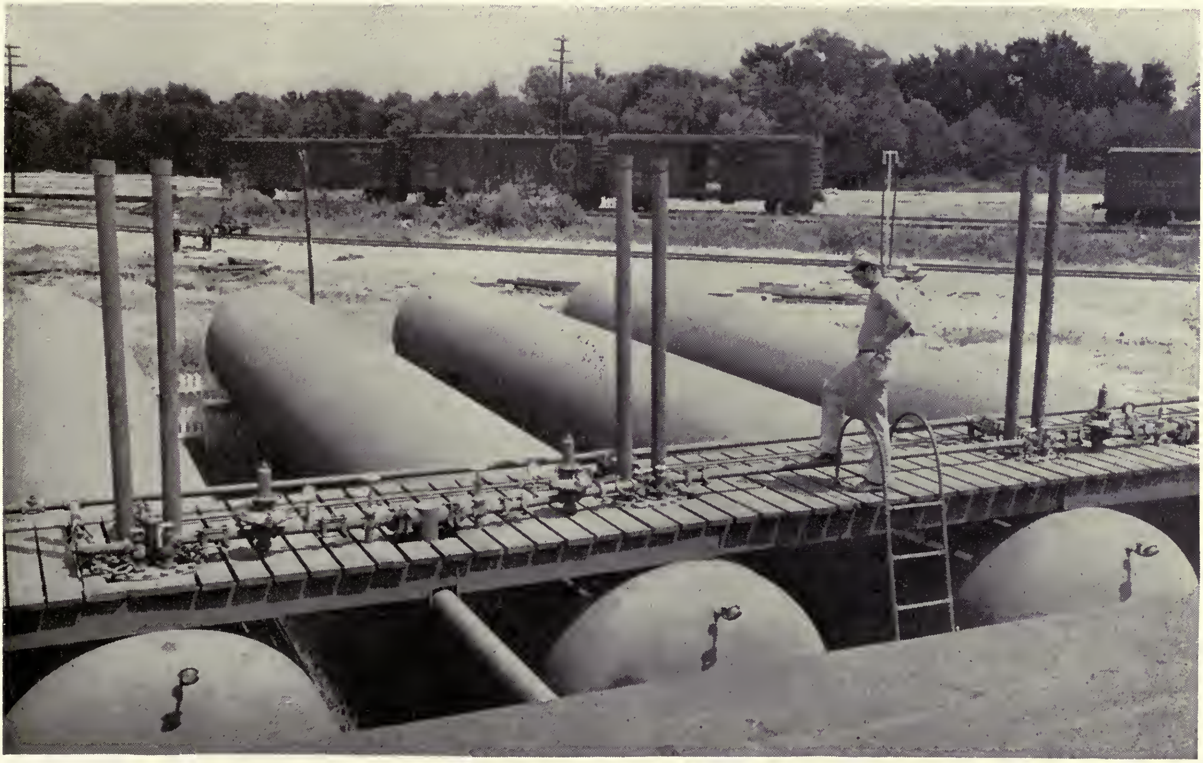
1. Retail purchase by the tenant is the usual arrangement in private housing. The utility company generally installs and maintains the exterior distribution system and meters and collects the charges. The regular utility rates usually apply.
2. Wholesale purchase by the project almost always results in lower gas or electricity costs. The fuel or energy may be purchased through a master meter or several meters, in which case the liability of the utility company ends at the meter. The possibility of having the utility company supply, repair, maintain, and insure the exterior distribution system in whole or in part, or any equipment (such as ranges, refrigerators or heaters) should be investigated. This arrangement may prove advantageous to the project. On the other hand, in some cases it may be more economical for the project to install and maintain the distribution systems, thereby absorbing a considerable portion of the utility charges. The utility analysis may indicate the necessity for considering project generation of energy, especially where the rates are unusually high.
3. Purchased steam may occasionally be available to a project. It is purchased on a wholesale basis for space and domestic water heating.

The starting point of all negotiations is the lowest published wholesale rate applicable to the particular utility combinations and load characteristics. It may be advantageous to the project for the utility company to establish new rate structures for public housing developments. The load factor characteristics, absence of non-payment losses, and uniform equipment facilities should enable the utility company to handle the project as an increment load with little added investment.

RATE NEGOTIATION OBJECTIVES

Rate negotiation objectives are principally:

1. Distribution system provided in part or in full by the utility company.
2. New rate structures with lower charges applied.
3. Applicability clauses of industrial rates extended to housing projects, resulting in reduced cost.
4. Project served at a lower voltage than that normally permitted by rate.
5. Group meter readings totalled for a single billing.
6. Check meters furnished, maintained, read, and charges billed by the utility company.
7. Maintenance service and repair work for all or part of the installation, including equipment furnished by others, provided by the utility company free, or at reduced cost.
8. Demand charges limited by the utility company regardless of actual demands.
9. "Ratchet clauses" eliminated from rates by the utility company.



Mechanical and Electrical Design

THE subjects discussed in this chapter —plumbing, heating and electrical systems—are closely related to the fundamental objectives of public housing: health and economy. In summary, it may properly be said that FPHA low-rent housing has met these objectives with a high degree of success; but experience also suggests that further advances are possible in sanitary plumbing, comfortable heating, and efficient lighting, combined with more economy in initial and operating costs.

Heating is probably the field which will benefit most from innovations and improvements resulting from research and experimentation. Electrical work will, likewise, show many improvements; but better application of existing knowledge is, perhaps, the first goal. In plumbing more research will undoubtedly add to the store of valuable information, but the greatest need at this time seems to be for the standardization of correct and simplified practice.

Many municipalities have adopted such simplified plumbing practices, based upon Government recommendations contained in the documents BH13[1] and BMS66[2], and there is a definite effort under way to promote further uniformity and acceptance on a nation-wide basis.

In view of this fact and especially because some of the low-rent housing projects used the simplified practices, the experience cited and the recommendations and data given here are based upon FPHA acceptance of the principles implicit in these practices. It is hoped that local authorities will give this problem their consideration, and that where local codes are believed to permit unsound practices or to involve needless expense, effort will be made to secure waivers of such provisions in the interest of better sanitation and greater economy.

Plumbing System

DRAINAGE SYSTEM IN BUILDINGS

As a general principle, the simplest, most direct and practical drainage layout has proved the most satisfactory in operation. The capacity of a drainage system should be based upon the possibility of frequent simultaneous discharge from a predetermined number of fixtures.

Fixture Units. The modern plumbing code has accepted the use of fixture unit loadings for determining pipe sizing of the drainage and venting systems. A fixture unit is a design factor for the drainage system so chosen that the load-producing values of plumbing fixtures can be expressed approximately as multiples of that factor. These values are given in Table I on the next page.

Sizing of Soil and Waste Piping. Table II gives the estimated maximum number of fixture units which may be drained safely into the various sections of a drainage system.

Soil and waste stack should be of the same diameter as the largest horizontal branch connected to it, unless the total number of fixture units on the stack exceeds the total of the branches. In that case the stack should be carried undiminished in size to the open air.

General Principles. The following practices have been found satisfactory in public housing:

1. Fixtures in one-story buildings, or on the top floor of multi-story buildings may be drained safely without individual venting if they are so grouped that the farthest trap is within the distances shown in Table III. (See also Figures 1 and 2, below).
2. The traps for lavatory and bath (or shower) in a

---

[1] Recommended Minimum Requirements for Plumbing, BH13. National Bureau of Standards. Government Printing Office, 1933.

[2] Building Materials and Structures Report, BMS66. National Bureau of Standards. Government Printing Office, 1940.

bathroom group may be served by the continuous vent for the lavatory waste only. (Figure 2, opposite).

TABLE I

FIXTURE UNIT VALUES

Type of fixture	*Trap size*	*Fixture units*
	Inch	
Lavatory—residence	1¼	1
Lavatory—public	1½	2
Bathtub—residence	1½	2
Bathtub—public	2	4
Shower stall—residence	1½	2
Shower stall—public	2	4
Water closet—residence		6
Water closet—public		10
Kitchen sink—residence	1½	2
Kitchen sink—public	2	4
Laundry tub	1½	2
Combination fixture	1½	2
Combination fixture	2	4
Service sink (slop sink)	3	3
Drinking fountain		½
Urinal—public	1½	2
Urinal—public	3	3
Floor drain	3	4

TABLE III

RELATION OF PIPE SIZE TO DISTANCE BETWEEN TRAP AND VENT

Size of pipe	*Maximum distance*
Inch	Feet
1¼	2
1½	4
2	6
3	9
4	12

3. A three inch soil stack and house drain is adequate for an individual unit consisting of one bathroom group, or for bathroom and kitchen sink. (Figures 1 to 4, opposite).
4. A vent is connected most effectively at a distance from the trap weir not greater than that shown on Table III, if the total fall of the branch waste is not greater than one diameter of the drain to which the vent connects. (Figure 5).
5. Where two lavatories or two sinks are connected back to back provide long turn pattern "TYs" at the point of intersection in order to avoid cross flow from one fixture into the other. (Figure 6).

TABLE II

MAXIMUM FIXTURE UNITS

Pipe size	*Maximum fixture units that may be connected to—*						
	Vertical soil and waste stack	*Horizontal branch or at one-branch interval on stack*			*House drain and sewer or other drain receiving discharge from more than one-branch interval*		
		⅛″ fall	*¼″ fall*	*½″ fall*	*⅛″ fall*	*¼″ fall*	*½″ fall*
1¼	1		1	1			
1½	3		3	3			
2	12		6	9		8	12
2½	35		13	18		18	25
3	[1]75		[2]32	[2]45		[1]46	[1]64
4	400	110	150	225	150	200	300
5	1,000	250	350	490	360	500	700
6	2,200	460	700	950	625	950	1,300
8	5,000	1,400	1,800	2,200	1,950	2,800	3,900

[1] Not over 2 water closets.

[2] Not over 1 water closet.

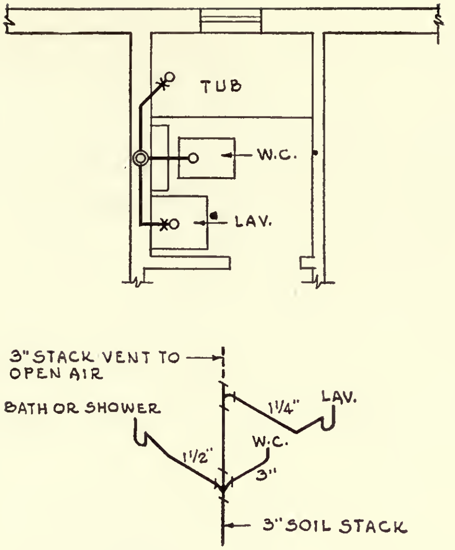


Figure 1. Single vent for top-floor bath (lavatory farthest from outside wall)

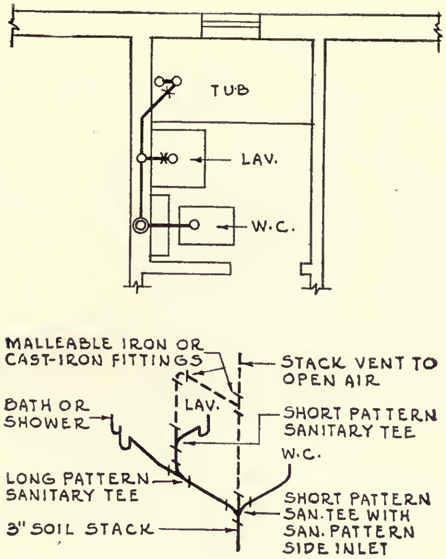

TUB
LAV.
W.C.
MALLEABLE IRON OR CAST-IRON FITTINGS
STACK VENT TO OPEN AIR
BATH OR SHOWER
LAV.
SHORT PATTERN SANITARY TEE
W.C.
LONG PATTERN SANITARY TEE
SHORT PATTERN SAN. TEE WITH SAN. PATTERN SIDE INLET
3" SOIL STACK

Figure 2. Single vent for top-floor bath (w. c. farthest from outside wall)

Note: Stack venting of a bathroom group is not desirable except when the fixtures and stack are located as shown

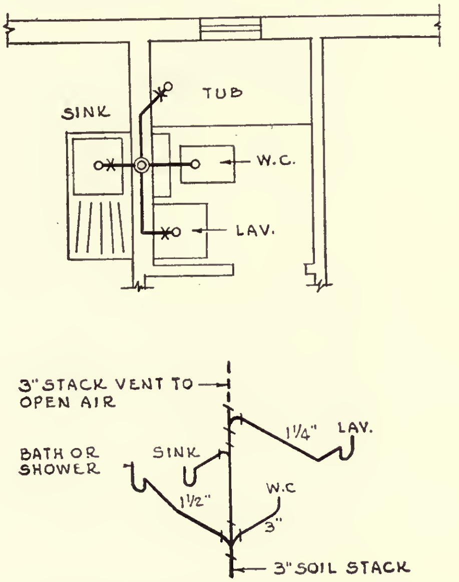


Figure 3. Single vent, bath and kitchen (lavatory farthest from outside wall)

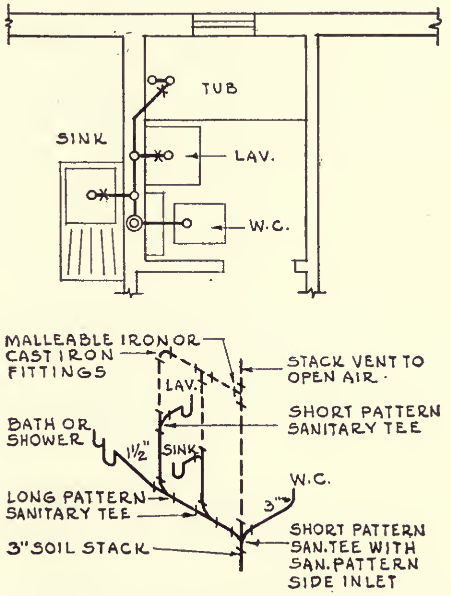

TUB
SINK
LAV.
W.C.
MALLEABLE IRON OR CAST IRON FITTINGS
STACK VENT TO OPEN AIR
LAV.
SHORT PATTERN SANITARY TEE
BATH OR SHOWER
1½"
SINK
W.C.
3"
LONG PATTERN SANITARY TEE
SHORT PATTERN SAN. TEE WITH SAN. PATTERN SIDE INLET
3" SOIL STACK

Figure 4. Single vent, bath and kitchen (w. c. farthest from outside wall)

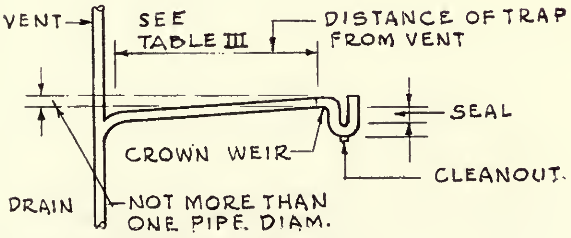


Figure 5. Trap and vent connection

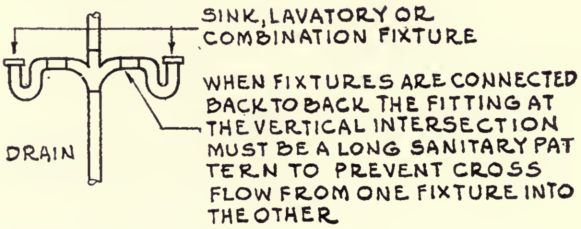

SINK, LAVATORY OR COMBINATION FIXTURE
WHEN FIXTURES ARE CONNECTED BACK TO BACK THE FITTING AT THE VERTICAL INTERSECTION MUST BE A LONG SANITARY PATTERN TO PREVENT CROSS FLOW FROM ONE FIXTURE INTO THE OTHER
DRAIN

Figure 6. Back-to-back connection

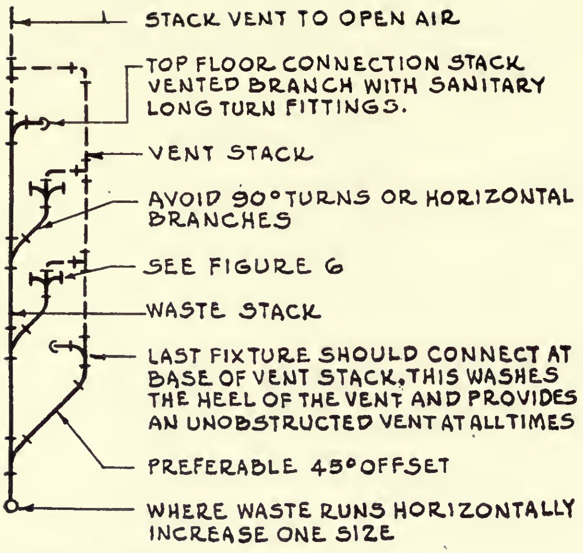

STACK VENT TO OPEN AIR
TOP FLOOR CONNECTION STACK VENTED BRANCH WITH SANITARY LONG TURN FITTINGS.
VENT STACK
AVOID 90° TURNS OR HORIZONTAL BRANCHES
SEE FIGURE 6
WASTE STACK
LAST FIXTURE SHOULD CONNECT AT BASE OF VENT STACK, THIS WASHES THE HEEL OF THE VENT AND PROVIDES AN UNOBSTRUCTED VENT AT ALL TIMES
PREFERABLE 45° OFFSET
WHERE WASTE RUNS HORIZONTALLY INCREASE ONE SIZE

Figure 7. Waste stack diagram

6. Sink or combination sink and tray waste stacks should avoid horizontal runs in order to prevent repairs because of stoppages. (Figure 7).

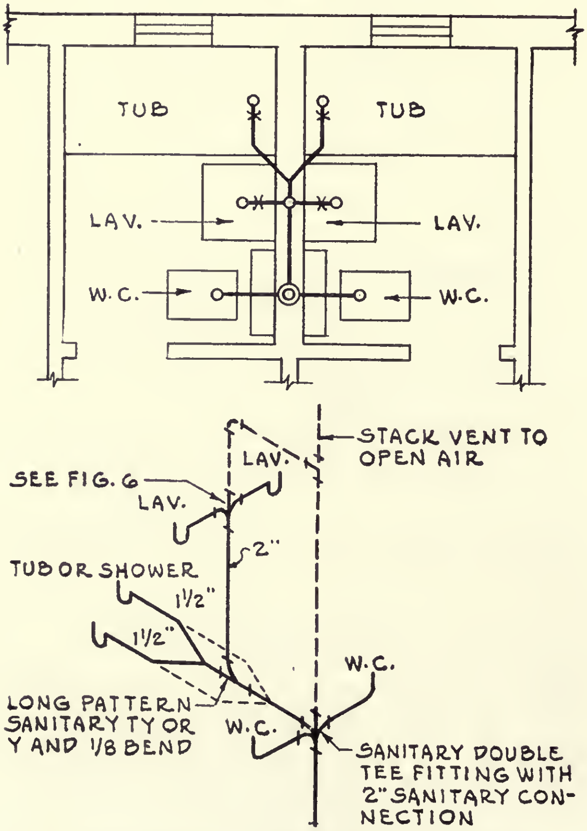

TUB
TUB
LAV.
LAV.
W.C.
W.C.
STACK VENT TO OPEN AIR
LAV.
SEE FIG. 6
LAV.
2"
TUB OR SHOWER
1½"
1½"
W.C.
LONG PATTERN SANITARY TY OR Y AND 1/8 BEND
W.C.
SANITARY DOUBLE TEE FITTING WITH 2" SANITARY CONNECTION

Figure 8. Back-to-back combination with double tee fitting

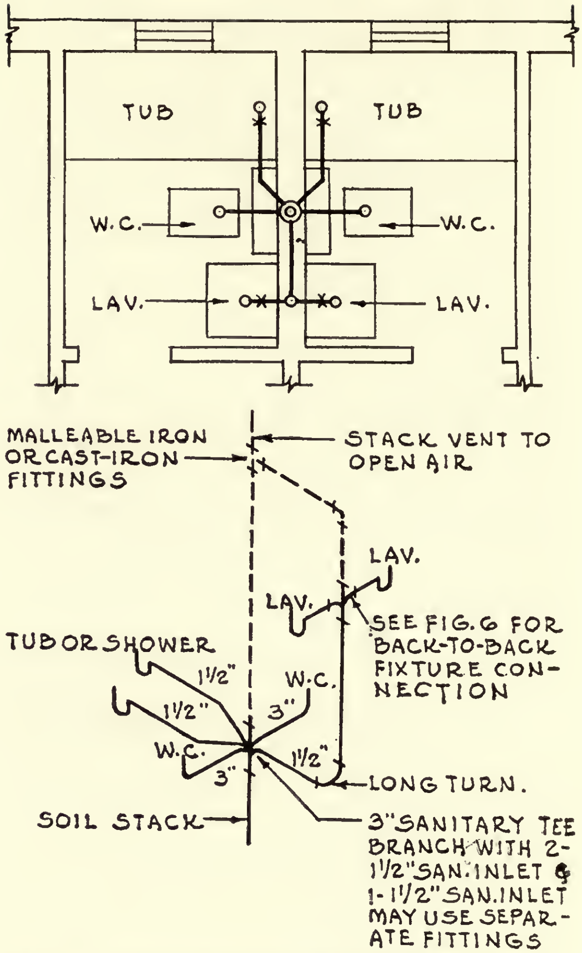
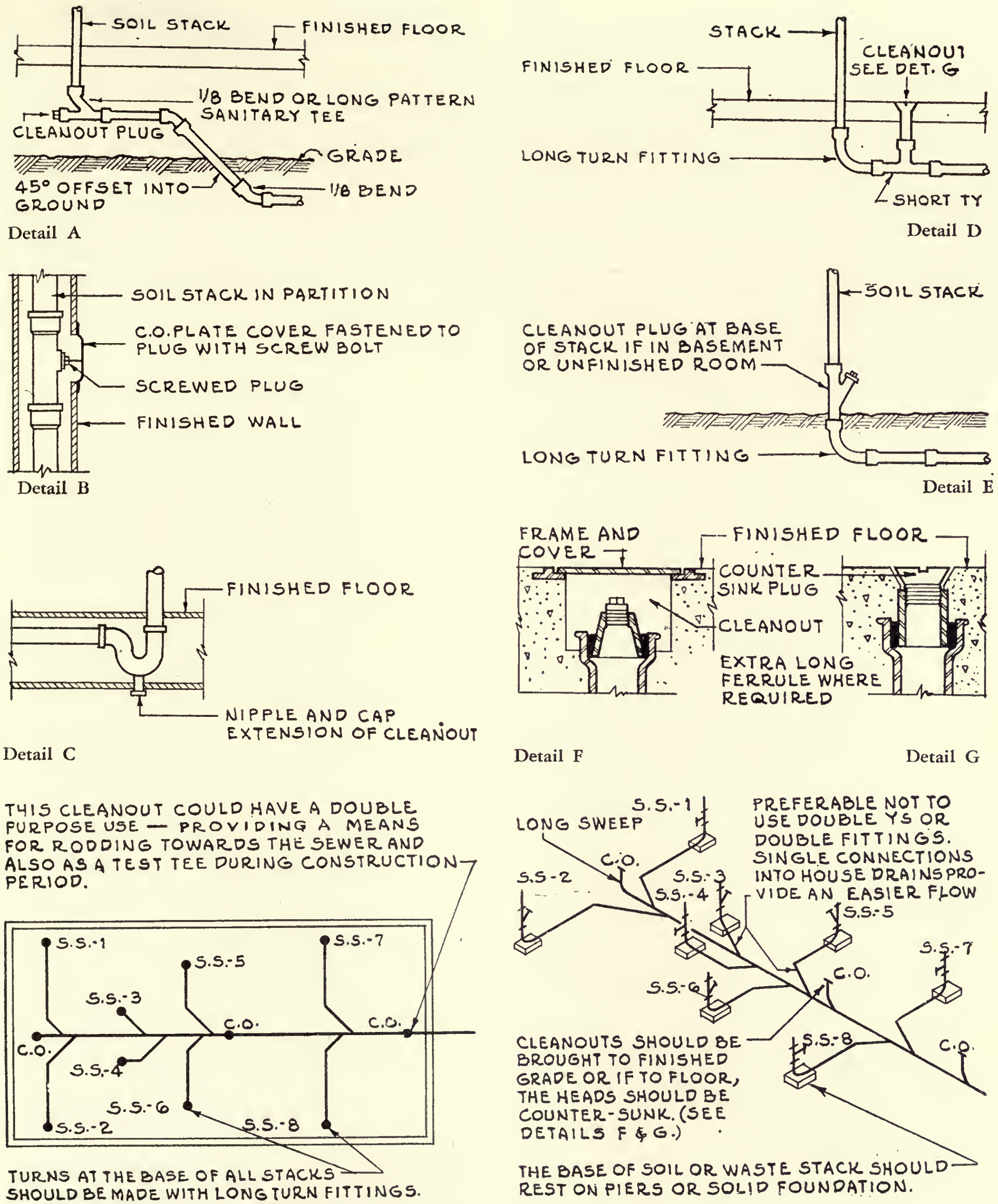

TUB
TUB
W.C.
W.C.
LAV.
LAV.
MALLEABLE IRON OR CAST-IRON FITTINGS
STACK VENT TO OPEN AIR
LAV.
LAV.
SEE FIG. 6 FOR BACK-TO-BACK FIXTURE CONNECTION
TUB OR SHOWER
1½"
1½"
W.C.
3"
W.C.
3"
1½"
LONG TURN.
SOIL STACK
3" SANITARY TEE BRANCH WITH 2-1½" SAN. INLET & 1-1½" SAN. INLET MAY USE SEPARATE FITTINGS

Figure 9. Back-to-back combination with tee branch

7. Back-to-back bathroom piping combinations operate satisfactorily if proper care is taken to provide long turn sanitary fittings, and if the horizontal branch from bathtubs or showers connects either between the lavatory and water closet or independently into the soil stack. (Figures 8 and 9).

> The back-to-back sinks in the two bedroom units were hooked into the waste with a right angle connection instead of "Ys", so that water from one was always backing into the other. This has been remedied by installing "Ys". — Pennsylvania

8. Sloping fixture drains and horizontal branches three inches in diameter or less should have at least ¼ inch fall per foot; such a pitch provides scouring velocities.
9. Drains should not have house traps or other obstructions; and changes in direction should be avoided.


SOIL STACK
FINISHED FLOOR
1/8 BEND OR LONG PATTERN SANITARY TEE
CLEANOUT PLUG
GRADE
45° OFFSET INTO GROUND
1/8 BEND
STACK
CLEANOUT SEE DET. G
FINISHED FLOOR
LONG TURN FITTING
SHORT TY
SOIL STACK IN PARTITION
C.O. PLATE COVER FASTENED TO PLUG WITH SCREW BOLT
SCREWED PLUG
FINISHED WALL
SOIL STACK
CLEANOUT PLUG AT BASE OF STACK IF IN BASEMENT OR UNFINISHED ROOM
LONG TURN FITTING
FINISHED FLOOR
NIPPLE AND CAP EXTENSION OF CLEANOUT
FRAME AND COVER
FINISHED FLOOR
COUNTER SINK PLUG
CLEANOUT
EXTRA LONG FERRULE WHERE REQUIRED
THIS CLEANOUT COULD HAVE A DOUBLE PURPOSE USE — PROVIDING A MEANS FOR RODDING TOWARDS THE SEWER AND ALSO AS A TEST TEE DURING CONSTRUCTION PERIOD.
S.S.-1
S.S.-7
S.S.-5
S.S.-3
C.O.
C.O.
C.O.
S.S.-4
S.S.-6
S.S.-2
S.S.-8
TURNS AT THE BASE OF ALL STACKS SHOULD BE MADE WITH LONG TURN FITTINGS.
S.S.-1
LONG SWEEP
PREFERABLE NOT TO USE DOUBLE YS OR DOUBLE FITTINGS. SINGLE CONNECTIONS INTO HOUSE DRAINS PROVIDE AN EASIER FLOW
C.O.
S.S-2
S.S.-3
S.S.-4
S.S.-5
S.S.-7
C.O.
S.S.-6
S.S.-8
C.O.
CLEANOUTS SHOULD BE BROUGHT TO FINISHED GRADE OR IF TO FLOOR, THE HEADS SHOULD BE COUNTER-SUNK. (SEE DETAILS F & G.)
THE BASE OF SOIL OR WASTE STACK SHOULD REST ON PIERS OR SOLID FOUNDATION.

Detail A

Detail D

Detail B

Detail E

Detail C

Detail F

Detail G

Figure 10. Cleanout connections and details

Cleanouts. Cleanouts in the drainage system should be easily accessible. In many projects, this need has been overlooked and it has been the cause of insanitary conditions and of maintenance difficulties. In order to rod a drain without cleanouts, the maintenance crew must punch and drill holes in the drainage piping. These holes are seldom closed properly, causing sewer gas and even drainage to escape.

A cleanout should be placed at every change of direction greater than 45 degrees in the house drain; one is needed near the point of exit in large buildings and one at the foot of each stack. The distance between cleanouts on a horizontal drain should not be more than fifty feet. This is the most convenient distance for a rodding wire or snake operated by one man.

Cleanout plugs at finish floor level in a walking space, or in a boiler room where equipment is rolled over floor, should be provided with countersunk heads to prevent accidents and breakage of plug or piping.

Overhead cleanouts should not be placed above any space where food is prepared or consumed, or over domestic water tanks.

VENTS AND VENTING

Vents serve three purposes in a drainage system:

1. Prevention of back pressures that otherwise would obstruct the free flow of sewage through the system—performed by the main vent stack and its branches.
2. Protection of trap seals from positive and negative pressures developed by the flow of sewage—performed by relief vents.
3. Prevention of trap siphonage—performed by back vents.

Several forms of group venting have been found to give as good protection against siphonage of trap seals as individual vents—in some cases better.

Under certain conditions, wet vents have proved perfectly satisfactory; actually, all horizontal branches in any vented drainage system serve as wet vents.

A vertical continuous waste and vent has proved adequate for two fixture traps when both fixture drains connect with a vertical drain or stack at the same level, if the two fixture drains and the developed length and total fall of the drains are within the limits shown in Figure 1.

Isolated fixtures should in all cases be provided with a back vent within the distances shown on Table III from the trap weir of the fixture.

A group of similar fixtures may be installed on one horizontal branch, with the traps protected by a circuit, or a loop vent connected to that branch in front of the last fixture drain.

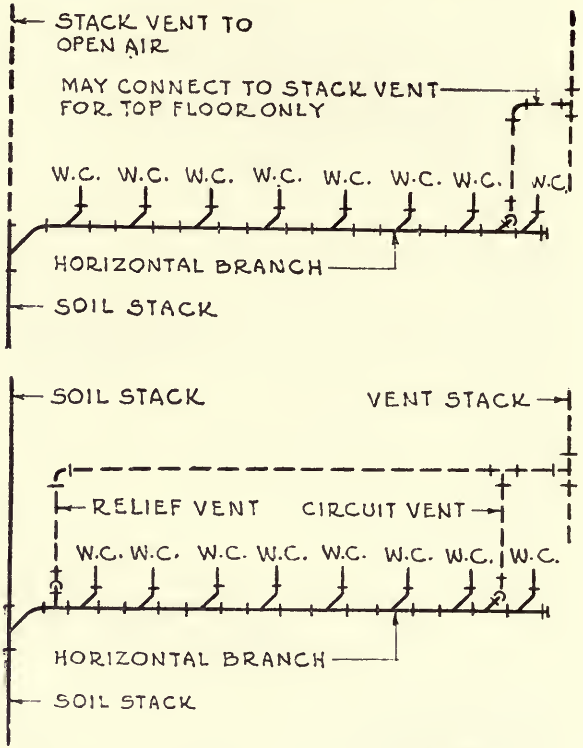

STACK VENT TO OPEN AIR
MAY CONNECT TO STACK VENT FOR TOP FLOOR ONLY
W.C. W.C. W.C. W.C. W.C. W.C. W.C. W.C.
HORIZONTAL BRANCH
SOIL STACK
SOIL STACK
VENT STACK
RELIEF VENT
CIRCUIT VENT
W.C. W.C. W.C. W.C. W.C. W.C. W.C. W.C.
HORIZONTAL BRANCH
SOIL STACK

Figure 11. Circuit and loop vent: intermediate floor and (above) top floor

TABLE IV

SIZE AND LENGTH OF VENTS

Diameter of soil or waste	*Fixture units on soil or waste stack*	*Diameter of Vent*					
		1¼″	1½″	2″	2½″	3″	4″
		Maximum length of vent (ft.)					
1¼	1	5	.....	.....	.....	.....	.....
1½	4	30	75	150	.....	.....	.....
2	10	20	70	125	.....	.....	.....
2	15	.....	50	100	.....	.....	.....
2½	20	.....	40	75	300	.....	.....
2½	35	.....	30	75	200	.....	.....
3	25	.....	20	70	150	700	.....
3	40	.....	.....	50	130	650	.....
3	80	.....	.....	40	120	600	.....
4	100	.....	.....	30	100	500	600
4	200	.....	.....	20	75	400	450
4	400	.....	.....	.....	50	300	400

Table IV gives vent dimensions for various sections of the drainage system and the estimated number of fixture units that may be attached to them safely and effectively.

In connection with the use of Table IV, note that the length of the main vent is based upon the total developed length as follows:

1. From the lowest connection of the vent system with the waste stack, or house drain (or its branches) to the terminal of the vent if it is carried separately to the open air.
2. Where there is danger of frost closure of the vent terminal, its size should be increased from a point at least one foot below the roof to one size larger than stack size, or, in any case, to not less than three inches in diameter.

SIZING OF LEADERS

Leaders should be sized on the basis of maximum roof area with reference to the following table.

TABLE V

SIZE OF LEADERS

Diameter (in.)	*Square feet of roof area*			
	Vertical leader	*Horizontal drain*		
		⅛" *fall*	¼" *fall*	½" *fall*
2	500	350	509	720
3	1,500	1,030	1,490	2,120
4	3,100	2,230	3,320	4,610
5	5,400	5,510	7,950	11,400
6	8,400	6,480	9,300	13,320

Note: The table above is based on a maximum rate of rainfall of four inches per hour. It should be adjusted proportionately for the local rainfall.

WATER DISTRIBUTING SYSTEM

Two closely related factors concern the water supply distributing system within a building. The first is the proper sizing of the piping system with its fittings and appurtenances, and the second is the type of water that is to flow through the piping system. It has been established that one of our greatest sources of maintenance, repair, and replacement expense occurs if one or the other has been overlooked or ignored.

Water composition is discussed below under "Water Corrosion." The design of pipe sizes outlined in Table VI is based on data reported by the management staffs of a number of projects. Although reports indicate that peak demands of water vary in different parts of the country because of tenant habits, certain general assumptions for estimating pipe sizes can be made. In any case the problem is not complicated because the designer is dealing with small groups of fixtures rather than with large ones. Water supply pipe sizes found most desirable in the operation of various fixtures based on average water pressure (40 pounds per square inch) are shown in Table VI.

TABLE VI

Fixture	*Pipe sizes*	*Flow GPM*
Lavatory	½	4
Bathtub	¾	10
Shower over bathtub	½	7
Water closet (tank type)	½	4
Water closet (flush valve)	1¼	30
Kitchen sink	½	6
Laundry tray (single)	½	7
Laundry tray (double)	½	14
Hose bibb	½	5

The number of fixtures and pipe sizes which have been found satisfactory, with allowances for simultaneous usage, are given in Table VII.

TABLE VII

Pipe Diameter (Inches)	*Maximum Number of Fixtures*[1]
¾	4
1	8
1¼	18
1½	50
2	110
2½	170
3	400

[1] Based on ½" branch size.

Technical material, such as charts, demand factors, curves, etc., for sizing the water system can be secured from many technical books on the subject. BMS66 contains recommendations on this subject.

Experience in many housing projects has shown that to reduce the size of the pipe to a minimum is poor economy, particularly where lime deposits and internal corrosion will reduce the orifice of small piping in time. Also, high velocities developed in small pipes tend to increase pipe noises and water hammer.

CONTROL VALVES

1. In many projects, there is only one shut-off valve to a building with several dwelling units. This has caused excessive maintenance costs. If each dwelling unit is controlled by a shut-off valve repairs can be made easily.
2. Shut-off valves placed in crawl spaces are difficult to get at. A shut-off valve in the bathroom, kitchen, or utility room saves time for the maintenance man and trouble for the tenant.
3. Water piping in each unit should be arranged so that it can be shut off independently and the piping should be so graded that it can be drained. This has been found essential to prevent water freezing in pipes when a unit is vacated during the winter.

> Shut-off valve needed for each dwelling unit, located within unit. — Regional Report
>
> Stopcocks and valves should be provided for each dwelling unit instead of for each building. Hose bibbs should be on walls for easy maintenance, instead of in lawns or basements. — Pennsylvania
>
> Water shut-offs should be inside and there should be one for each unit, whether house or apartment.— New York
>
> Should be able to drain and shut off water from system during winter vacancy. Valve should be located adjacent to access doors. — Regional Report

PRESSURE-REDUCING VALVES AND RELIEF VALVES

1. Pipe noises and leaks occur in many projects where the water pressure is over 70 pounds per square inch and no provision has been made for reduction in pressure. The installation of a pressure-reducing valve at each building with several dwelling units is a remedy. One or more pressure-reducing valves located at the service entrance main will solve the problem for projects composed of individual houses.
2. Many accidents have been caused by improperly designed relief valves on hot-water tanks. The fusible-type temperature relief valve has caused property damage because it takes time to replace it with a new fusible plug. This also applies to the spring-type pressure relief valve requiring manual re-set. A good combination temperature and pressure relief valve is a good, and cheap, investment.
3. Safety valves for large hot-water tanks often have been too small or have been installed in the wrong places. The most effective location for relief valves is directly into the tank or as close to it as practicable, but always above the top of the tank discharge outlet.

> Project-operated hot water: Provide a by-pass connection between hot and cold water directly above the hot-water tank, when single tanks are provided, to permit the draining of the hot-water tank without taking the pressure off the piping system. This will cut down on the number of floods caused by tenants leaving faucets open when the water is returned to the system. — Regional Report
>
> Non-automatic gas heater with overflow pipe has resulted in several cases of flood due to carelessness or ignorance. — Pennsylvania

Hose connections at front and back of each dwelling are desirable . . .

MISCELLANEOUS

1. It is desirable in row houses to have individual hose connections both at the front and the back of each dwelling.
2. An apartment building should have hose bibbs located so that a hose length of 100 feet will reach all spaces around the building. Hose bibbs placed about 18 inches above grade on walls are more easily maintained than if they are installed in lawns or pavements.
3. Return circulation on hot water supply piping has been found to save fuel if the total run of the main exceeds 100 feet.
4. Self-contained water storage heaters are difficult to maintain at their original thermostatic setting of 150 degrees F. because the tenants tinker with the setting. Either a temperature control setting inaccessible to tenants or a locking type device will save the maintenance crew a great deal of trouble and time.
5. Selection of the material for hot-water tanks best adapted for the water characteristics of the project will prevent frequent replacements.
6. Large storage tanks with an interior cement coating have given excellent results in corrosive water zones.
7. Neutral connectors between two dissimilar metals, such as copper tubing and galvanized tanks, have prevented electrolysis and consequent disintegration.

. . . although occasionally a housekeeper will carry out a pail of water

Pipes in crawl spaces should be protected from corrosion

8. Continuous-operation circulating pumps have been more costly and less satisfactory than those set to operate on-and-off by an aquastat inserted on the return line.
9. Asphaltum paint has been found useful to prevent corrosion of metal piping and is particularly useful when pipes run in basements or crawl spaces.
10. Water piping often freezes in exterior walls. Interior partitions and interior pipe spaces are safer locations.

PLUMBING FIXTURES AND TRIM

Plumbing fixtures for low-rent housing projects of the near future will not differ to any great extent from pre-war fixtures in materials and style, but will benefit by improvements started before the war. Experience with certain types of fixture trim found best adaptable to low-rent work is summarized below.

Materials. Cast iron and formed metal, with acid-resisting enamel, have been found to be well suited for public housing projects; regular enamel does not stand up as well to the hard usage given these fixtures. On the other hand, vitreous china and vitreous glazed earthenware water closets and lavatories are strong, easily kept clean, and look well.

They do not chip or break any more easily than do fixtures made of other materials.

Projects with separate laundry trays in basements or utility rooms, or on the porches (in mild climates), may have the trays made of cheaper materials such as cement, concrete, soapstone, or alberene stone.

Fixture Trim. Brass trim, chrome plated over nickel, gives the longest service and has the best appearance.

Compression-type faucets are best adapted for residential use and prevent water hammer because they close slowly; in addition, the type with a renewable seat or that with a seat cast in a separate barrel are easily replaced. One thing to check is the availability of replacement parts; special-feature faucets have been found undesirable because parts cannot be procured easily. Mechanically-operated wastes on bathtubs and lavatories have required a great deal of maintenance, as have also lifts, pop-up or other types with concealed links, chains, or parts. The common chain and rubber stopper is cheap and is less troublesome.

> Faucets on laundry tubs too cheap. New brass seats installed. Management says only the best should be used. — New York

> Plumbing fixtures — high grade reduces maintenance costs. — Association Report

Bathtubs. Bathtubs with flat bottoms and straight sides diminish the possibility of accidents. A wide rim with a grab rail (or separate grab rail in the wall) prevents falls. Other desiderata are large wastes for quick emptying, and bathtub hangers built into the wall.

Where a shower head is installed over the bathtub, the use of one pair of control valves with transfer (lift type) or lever arranged to serve both bathtub and shower has proved the most economical and the safest in operation, as the transfer is arranged to return to its original position when the water is shut off. This prevents accidental scalding or the possibility of water flowing from the shower head when the bath supply is meant to be turned on.

> Consistent definite preference for tubs as against showers in all projects among women interviewed. This is emphasized in projects which only have showers on the basis of difficulty of bathing young children. Many women prefer showers in summer and baths in winter, but if choice is imperative, would take tub. — Association Report

Water Closets. Water closets are chosen for efficient and quiet action. The three types commonly found are:

1. The siphon jet, which possesses the best design and quietest operation.
2. The reverse trap with jet, which compares favorably with the siphon jet although it has a smaller water seal, a smaller trap and less bowl surface covered with water. It is often used for housing projects as it is efficient in operation and low in first cost.
3. The wash down type is noisier, it is not provided with all the mechanical or sanitary features of the other two types, and it is more restrictive to water flow.

These three types of closets are fitted either with low-down or close-coupled tanks or with flush valves. The close-coupled tank has proved to be a maintenance problem unless a shim or support is provided between the back of tank and the wall. The tank should be fitted with an anti-siphon ballcock or air gap to prevent possible contamination by back siphonage into the water system. See A40.4, "Air Gaps and Backflow Preventers."[1]

A flat tank cover with its edges raised to prevent articles from slipping off is well liked by tenants.

Flush valve operated water closets require larger water pipe sizes than do those with tanks; this increases installation costs.

> Flushing valves with vacuum breaker preferred for toilets. Eliminates "tinkering" on the part of tenant and breaking tanks and covers. — Georgia

Water closet seats manufactured from wood or composition with white baked impervious finish can be kept clean and will withstand hard usage. Weak or poorly constructed hinges have caused high replacement costs. A cover is not a luxury; fewer bottles, jars and toys will find their way into the trap.

> Removed battleship from toilet. — Virginia

Lavatory. A wall hung lavatory permits a clear floor. Some difficulty has been experienced when proper means for attaching the lavatory have not been provided. The outer rim of the installed lavatory should support 250 pounds. Occasionally a

---

[1] American Standards Association. New York, 1942

A low, portable tub is sometimes preferred to a laundry tray

light center leg was used because the wall support was insufficient. This happened, for the most part, in war housing construction with light partition members.

A four-inch center combination fixture with chain and stopper provides the least costly arrangement for public housing installations and assures tempered running water.

Kitchen Sinks. Dwelling units without basements or utility spaces are normally equipped with a combination sink and tray 42 to 48 inches long, depending upon the number of bedrooms. For one- and two-bedroom units, a 42-inch combination sink and tray has been found satisfactory; for three and four bedroom units a 48-inch combination is preferred. There has been a request for two laundry trays in three- and four-bedroom units. Two laundry trays, as a rule, are installed in utility rooms.

Enclosed cabinets under sinks have not been found suitable because they are breeding places for insects and are difficult to keep clean.

The washing machine is more than a two-foot dotted circle on a plan. It is a bulky affair, it comes in various designs, and it must be placed in working relation to the fixed laundry tray. In some low-rent dwellings, the tray is not the standard height (36 inches) and a washing machine cannot be used.

All of the 30 families visited own washing machines. Sinks in kitchens not adequate for large rinsings. — Pennsylvania

Combination sink and tray in kitchen constitutes adequate and satisfactory laundry facilities and is especially liked by tenants. — Regional Report

Women reported the combination sink-laundry tray inconvenient for laundry work even with the washing machine. One woman interviewed used a galvanized tub for rinsing clothes. Another said: "It's all

> right but it isn't as if you could put your clothes right through the wringer into running water — you have to grab them and take them over — you have to learn the art." — Michigan

> Washing diapers in the kitchen was objected to on sanitary grounds. — Pennsylvania

> Bathing of babies, hair washing, light laundry, generally done in kitchen sink-tub combination. — Association Report

> Sink and tray too small. — Washington State

> Tray and sink combination: Ideal. — Georgia

> In the best permanent project, sink and tray combinations are said to be adequate by the regional management adviser. — Texas

Sinks without laundry trays are sometimes installed in apartments where central laundries are provided.

> Some tenants (of apartments) wanted sink-tub combinations instead of just sinks. A trip to apartment laundries is difficult, especially in winter. — New York

Laundry work in the kitchen adds to condensation which is enough of a nuisance through cooking alone, particularly in small rooms with gas ranges. Some designers have installed kitchen vents in an effort to control condensation, and managers encourage their clients to keep the kitchen windows (especially steel casements) "cracked."

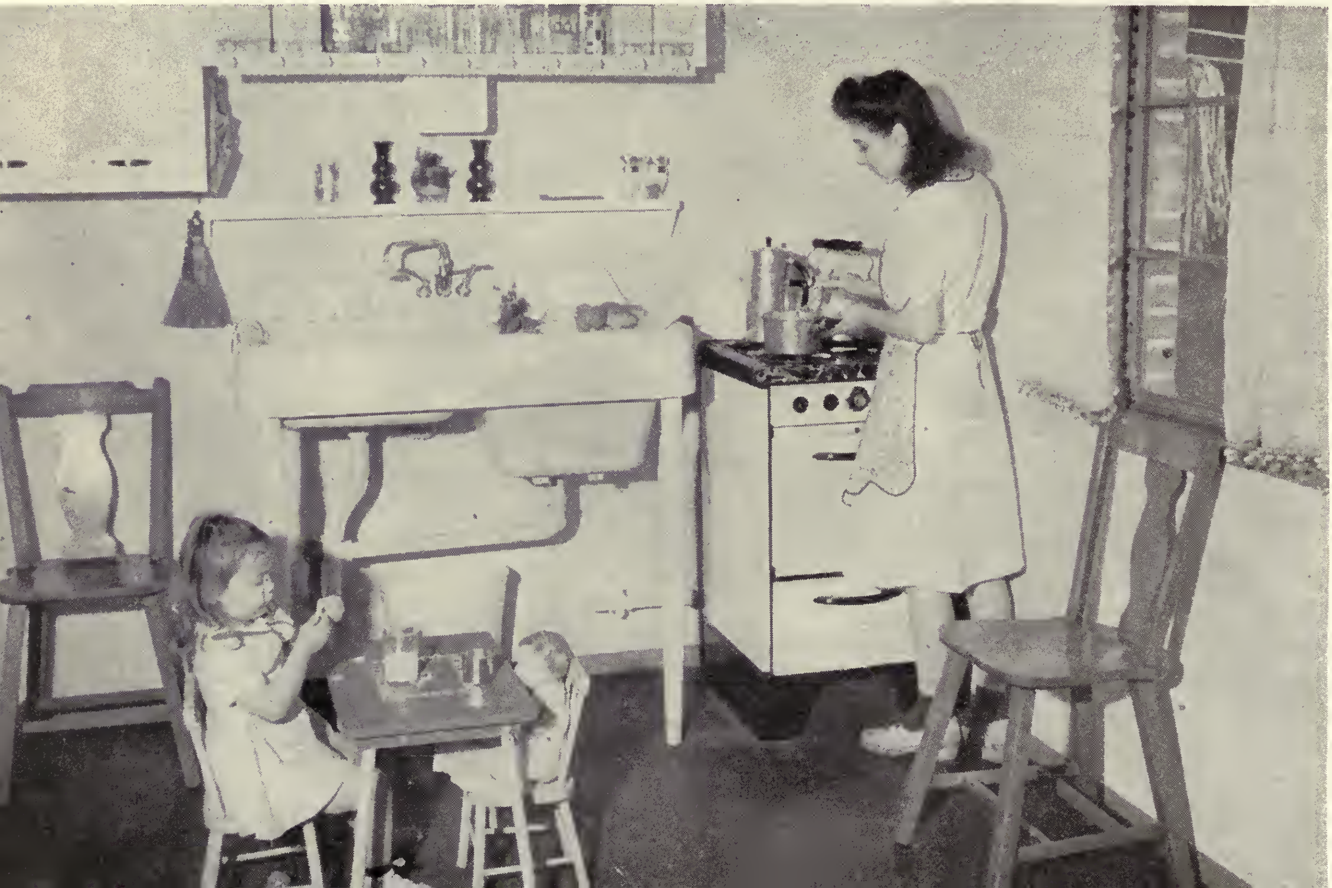
> Kitchen vents, especially if located near the range, would take off cooking vapors and thus help to reduce the amount of condensation. — New York

> I use the apartment laundry. I was washing in the kitchen all the time but it makes the house more damp. — New York

Details. The swinging spout is well received except in cases where it is set so low that a milk bottle or large kettle will not stand under it and dishes may easily be smashed. Hose sprays are not desirable as they add to the maintenance duties and may cause back-siphonage.

Experience has proved that roughing of a combination sink and tray with one trap is satisfactory, provided the trap is placed under the sink and the continuous waste is installed with a tee on the vertical waste column directly under the sink and is provided with a sanitary radius to prevent tray waste flowing back into sink compartment.

One trap may be used for sink and tray if installed correctly



Occasional splashing from the economical four-tray arrangement is compensated for by the opportunity to converse

Tenant-Owned Equipment. Kitchens are sometimes cluttered up with unused tenant-owned equipment stored there for lack of other space. Some managers recommend that project-furnished refrigerators and ranges be omitted from one-tenth of the dwellings, making adjustments as necessary. Local custom is probably the best guide in determining whether or not this is advisable.

> The consensus is that tenants should not be permitted to replace our gas ranges in any of the dwelling units. We recommend that local housing authorities discourage moving out project's own refrigerators and permitting tenants to install theirs in the kitchen. This situation represents a serious maintenance problem. — Regional Report

Fixtures for Project Facility Buildings. These should be of the same type as used in the dwelling units.

The water closets in public toilets should be fitted with open front seats without covers. Flush valve operated toilets are recommended for public buildings as their limited number would not increase the over-all cost perceptibly.

Wall-hung urinals, siphon jet, fitted with flush valves, are economical for small toilet rooms; for larger toilet rooms, stall-type urinals will be more advantageous.

Laundry trays in central laundries have been provided on occasion in sets of two, so arranged that one tenant will not splash other tenants while washing. A more economical layout consists of groups of four trays. The disadvantage of splashing is offset by the opportunity for conversation, and trays designed with barrier backs take care of most splashes. It should be noted that apartment dwellers in public projects do a considerable amount of laundering in their own quarters, and therefore the provision of a common laundry does not preclude the need for at least one laundry tray in the apartment.

Drinking fountains are usually installed in playground areas, in public halls and in office spaces, and must meet public health requirements. See "The Site Plan" for data on drinking fountains.

WATER CORROSION

The selection of piping materials and equipment is based on the analysis of the water supply which will serve the project, checked against local installations that have been in service under similar conditions over a period of years. In a housing development the total cost, including initial installation, maintenance and replacement expenses, should be analyzed with proper factors given to the replacement cost of short-lived material, if it is considered.

> We recommend that in future installations of hot-water heating systems, chemical analysis be made of the water supply to determine whether or not water treatment will be necessary or advisable, in which case the apparatus for feeding this treatment should be incorporated in the original installation. — Regional Report

Dissimilar metals in contact with each other will cause corrosion by galvanic action, for example, copper and galvanized ferrous pipe. Electric currents passing from iron into the water and back will cause iron to corrode. Hot water systems are always subject to a higher rate of corrosion than are cold water systems, particularly with water high in carbonate hardness.

Feed waters which are high in temporary hardness or sodium bicarbonate salts, as well as many water boiler treatments where sodas are used to soften the water, are the chief offenders in the deterioration of piping systems. Either oxygen or carbonic acids cause corrosive action, and the presence of both will develop corrosive effects quite rapidly. Usually an excess of carbonic acid will groove out the bottom of the pipe, and an excess of oxygen will cause pitting above the water line.

Soils contaminated with cinders, soils containing an appreciable amount of sulphur compound, or other soils which indicate reactions should be replaced with clean natural soil, or else the piping should be protected against outside corrosion by pipe enamel, bitumastic paint or bitumastic compound. "Research Paper RP-1602, Soil Corrosion Studies" [1] presents data on the effects of various soils on metals.

SOLAR HEATING OF DOMESTIC HOT WATER

Solar heat for domestic hot water has been used to advantage in a number of public housing developments on the West Coast and in the South. Two main systems are used: direct piping from a heater case to a dwelling, and indirect systems with units in series heating water in a storage tank which serves several dwellings.

The direct system is used in southern Florida and in parts of California where there is no danger of water freezing in the exposed pipes. It is more efficient and supplies somewhat hotter water than does the indirect method.

In regions where freezing may occur, an antifreeze liquid is circulated through the heating unit on the roof, and a coil inside the hot-water storage tank heats the water in the tank by convection.

A project in Georgia has one of the largest systems of this second type. For three years its 153 tanks have supplied the demands of 480 dwellings—34,920 gallons a day, an average of 72 gallons per dwelling or about 6 gallons over the average minimum needs of each dwelling.

In this group installation, several solar heating units on the roof heat the tank water supplied to several dwellings by convection, as described above. Three to four inches of rock wool insulation keeps the tank water hot for 72 hours or more.

Installations on other jobs have been so designed that the heater case serves to shade a window or a porch.

Orientation of the heater unit so that it receives

Indirect solar hot water heating

---

[1] National Bureau of Standards. Government Printing Office. September, 1944.

Storage tank hung under the roof

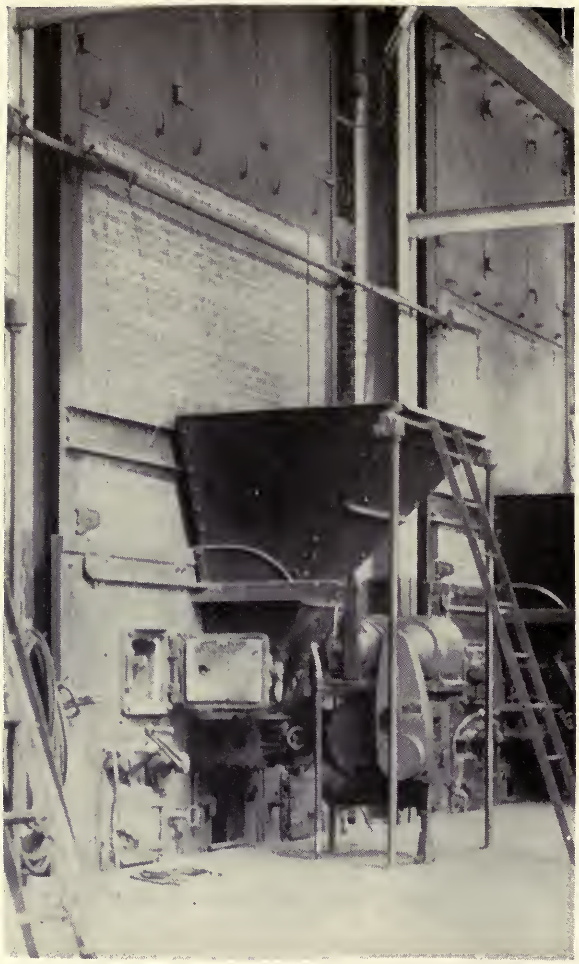
the greatest amount of sunshine throughout the year is very important. Even on cloudy days the solar heater will produce at least half of its full load.

Storage tanks are placed slightly above the level of heater cases. Tanks are usually hung horizontally close under the ridge of pitched roofs to allow headroom below: they are placed vertically on flat roofs, sometimes within a chimney-like enclosure.

> Solar hot-water heating has proven to be most satisfactory, and while the initial cost is slightly more than for other types of hot water heating, the operational and maintenance costs are insignificant. — Georgia

> Use of solar hot-water systems seems to be practical much farther north. — Regional Report

The direct method is used where there is no danger of freezing



Heating System

Ben Franklin wrote: "In travelling I have observed that in those parts where the inhabitants can have neither wood, nor coal, nor turf but at excessive prices, the working people live in miserable hovels, are ragged and have nothing comfortable about them. But when fuel is cheap (or where they have the art of managing it to advantage) they are well furnished with necessaries and have decent habitations." Fortunately, in almost any part of the country a cheap fuel is available, but "the art of managing it to advantage" is largely dependent upon the system that is selected for a project and the manner in which the engineer designs it.

It is not difficult, under ordinary circumstances, for the heating engineer to meet the requirements of the "Minimum Physical Standards." They are quite consistent with the present day approach to heating design. They recognize that body comfort rather than arbitrarily stated room temperature is the real objective of heating.

The discussion following is not concerned with current heating theories, familiar to engineers, but with problems that architects and engineers have considered jointly in the design of a heating system for low-rent developments.

The heating problem, relatively simple in commercial work, becomes complicated when applied to large groups of housing units intended to rent at such low rates that a subsidy is required to make up the difference between economic rent and a rent which the tenants are able to pay. Many factors which are either non-existent or of minor importance in connection with ordinary rental or privately-owned housing attain special significance when applied to large low-rental housing projects. The primary elements of this problem are:

1. Selection of the most economical combination of utilities. This selection includes consideration of fuels, electric consumption, operating labor, ash removal, repairs, maintenance, replacement costs, and related items.
2. Selection of a heating system and type of fuel consistent with the above and adaptable both to the site plan and to dwelling unit plans.

Since the heating design for public low-rent buildings is one of the most important single problems of the whole development, it must be resolved at an early stage of the planning and in light of all available experience. The various factors related to heating are described in the chapter, "Selection of Utilities."

With comparatively few exceptions, heating installations have given satisfactory performance, and in most cases this has been accomplished with relative economy. However, as is to be expected, performance and economy in some cases have been not entirely satisfactory.

MODERN IDEAS FOR HEATING

Many new methods of heating have been advanced, and doubtless more will continue to be advanced. Some of these ideas are extremely radical and some are adaptations of older systems. Among the more extreme proposals are those for solar heating of spaces, with and without heat storage. There are many advocates of radiant (or panel) heating in one or another form. Finally, some experience is available with respect to adaptations of fairly primitive systems to modern conditions: in this last category are heaters based on the Central European ceramic furnace and on the ordinary open fireplace.

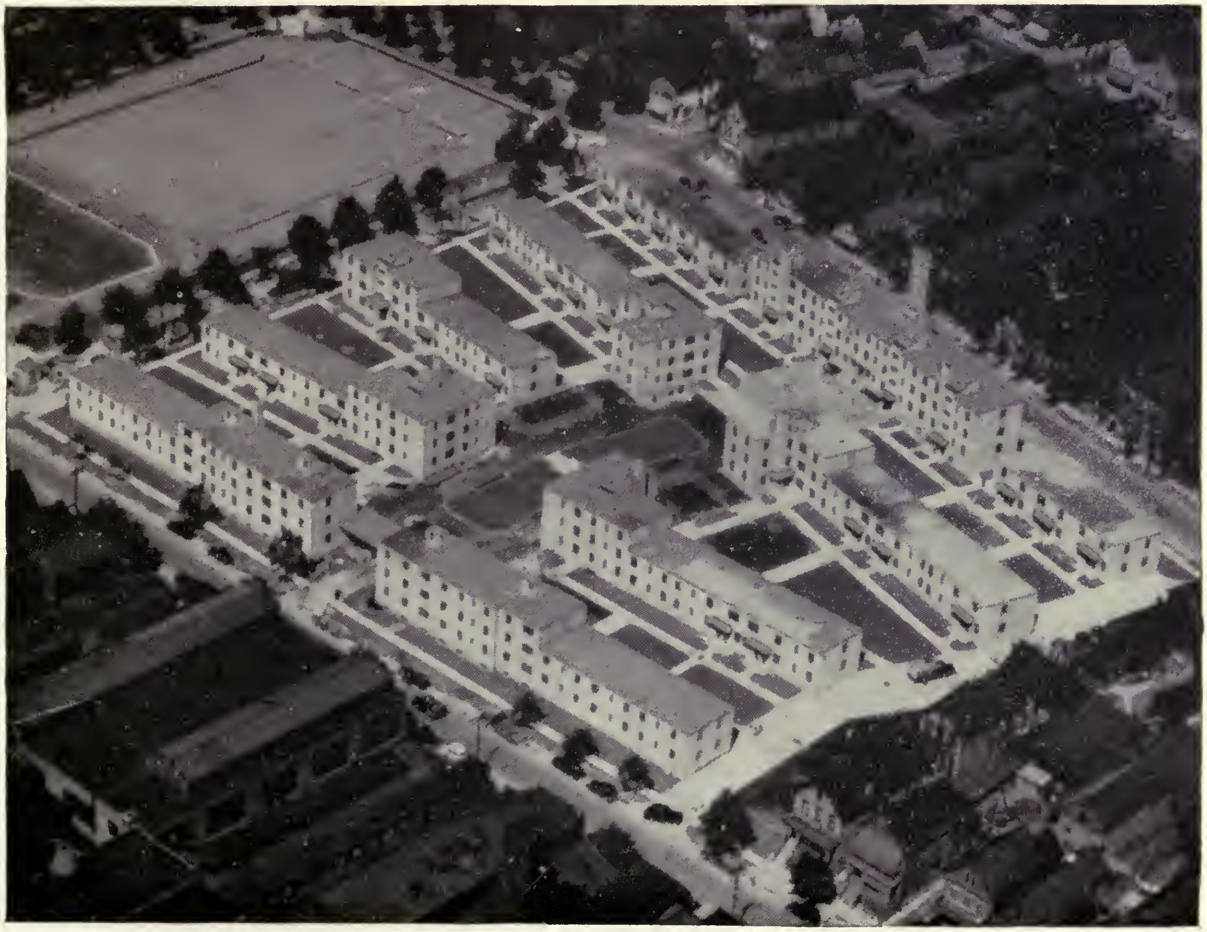
Ceramic heater: It increases the livability of the room by the comforting effect of heat radiation emitted by glazed surfaces which are not obtrusive. — Pennsylvania

It may be expected that local housing authorities and their technicians will in some instances propose these or other new heating methods, which will be reviewed with sympathetic interest. No such innovations should be considered, however, until there is a definite background of experience demonstrating the practicability of any radical departures from well-tried systems. The FPHA will continue to conduct research and to foster experimental work for the advancement of public housing and will disseminate any conclusions reached.

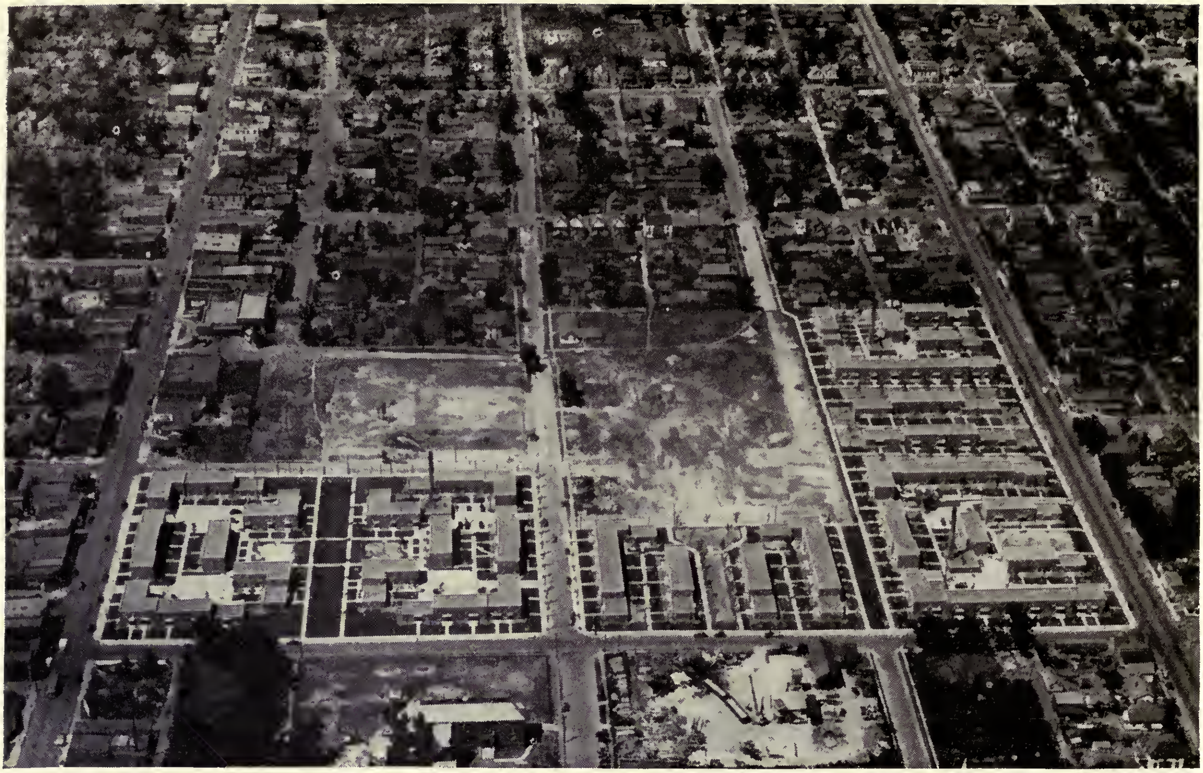
PROJECT-OPERATED OR TENANT-OPERATED HEATING PLANTS?

While we must not underestimate the importance of the economic analysis, the choice between a project-operated and a tenant-operated plant is often self-evident. Apartment buildings with coal or oil fuel, for example, lead logically to the project plant. Detached and twin houses naturally use individual tenant-fired plants. Row houses are, as a rule, equipped with tenant plants: in some cases, however, utility analyses indicate that fuels available or site conditions favor project plants.

It has been more difficult to determine the type of heating plant best suited to projects consisting entirely or in great part of flats. Here, the nature of



A central project plant is frequently used for apartment buildings



A project heated by group plants—note location of stacks

A project heated by tenant-operated plants the fuel shown by analysis to be least in cost may very well be the controlling factor. Where coal is the most economic fuel tenant plants should not be chosen unless a boiler or furnace supplying heat through a radiator or warm-air system can be placed in a basement or separate utility room on first floor, since carrying coal to upper floor units is undesirable. Oil has one definite drawback, namely, difficulty in refueling. Gas is well suited to individual heating plants in flats.

The most difficult case of all is the project consisting of a number of different dwelling types, required either because of a diversity of needs or range of income, or because of irregularities of the site. If multi-family structures predominate, and if the topography and the site layout are favorable to the distribution of heat to row houses or flats composing the rest of the development, project heating is usually indicated by the economic analysis. Tenant heating may be in order if gas is an exceptionally economical fuel. Or a combination of project- and tenant-operated plants has sometimes proved to be the correct solution, though this is likely to increase management work. On projects made up of row houses and flats in which coal is to be the fuel, project plants are usually chosen. When other fuels are available, tenant plants are more usual.

> Central heating system — satisfactory — no bad public relations. It helps reduce rents and seems the sensible thing to do. — North Carolina
>
> Group plants are expensive and inefficient compared with a central plant. Trucking service for ash removal multiplied by the number of plants is costly. — Pennsylvania
>
> Provision for central heating plants of fully automatic oil heat operation is recommended, if possible, in lay-out of development. Reduction in labor will materially reduce operating expenses and permit more efficient control of fuel. — Maryland
>
> We believe that a central heating system should be installed and heat and hot water be supplied to the tenants. — New Jersey

Tables VIII, IX and X list the fuel, heating plant, and type of heating system for over 600 projects, as of September 30, 1944. Nearly 400 of them are low-rent; the balance built under other public programs.

FUELS

It is important to realize at the earliest stage of design that the fuel selected affects the site layout, as well as the dwelling unit plan and the planning of buildings. Coal and oil for example, will require (in the case of tenant plants) roads convenient for deliveries.

The two examples following show how the types of fuel available contributed to the selection of heating systems.

1. In New England the winters are severe and fuel cost is an important item of the project operating expense. Normally, heavy oil (No. 6) can be purchased for about 3¢ a gallon. This oil is suitable only for large heating plants. Domestic fuels are

TABLE VIII

DISTRIBUTION OF PROJECTS BY TYPE OF FUEL FOR SPACE HEATING

Type of fuel:	Projects
Gas	177
Coal	298
Fuel oil	61
Other[1]	4
None	36
Projects not reporting	27

[1] Among other fuels used are: Purchased steam, wood, kerosene.

TABLE IX

DISTRIBUTION OF PROJECTS BY TYPE OF HEATING PLANT

Type of plant:	Projects
Tenant	347
Project central	163
Group[1]	46
None	36
Projects not reporting	11

[1] Group plants include building plants. See "Project Plants" below for definitions.

TABLE X

DISTRIBUTION OF PROJECTS BY TYPE OF HEATING SYSTEM

Type of system:	Projects
Steam	148
Hot water	60
Forced warm air	57
Space heater	257
None	36
Projects not reporting	45

more costly—sized anthracite sells for about $13 a ton, and fuel oil (light distillate), for about 7¢ or 8¢ a gallon. As a result, the greater part of the housing projects in this area were built with oil-fired central heating plants.

2. In sections of Ohio and western Pennsylvania where the cost of natural gas is relatively low and it can be burned as efficiently in domestic equipment as in project-operated plants, many of the projects were built with tenant-operated gas-fired heating plants.

> The automatic gas furnaces were liked by the tenants. — Committee Report

The problems of fuel storage are touched upon in the sections headed "Project Plants" and "Tenant Plants". Experience with different fuels in various types of equipment is summarized below:

Coal (both bituminous and anthracite) has been used extensively for all types of equipment. Boilers in project plants are generally stoker-fired; those in tenant plants, hand-fired.

Oil of heavy grades, such as Nos. 5 and 6, particularly the latter, has been used for the large project boilers, whereas the lighter grade, No. 3, has been used, although less often, for the smaller, fully automatically operated project boiler. Rotating cup burners and gun burners are most common. For the tenant plant, the lightest classified oil distillate (No. 1) has been used for space-heating equipment such as warm-air furnaces and space heaters. The burner most often used is the vaporizing pot type, dependent upon natural draft for effective operation. In connection with forced warm-air furnaces natural draft has sometimes been supplemented with small, electric, motor-driven blowers.

Gas, natural, manufactured, or mixed natural and manufactured, has been used for boilers, warm-air furnaces and space heaters, but most commonly for the latter two types of equipment.

> During the period in which the present two locally owned projects of this authority were developed, it was necessary to plan for use of coal as fuel for space heating because of the then current shortage of fuel oil. In the future, it is proposed that the use of fuel oil or gas for space heating be seriously considered. It is further contemplated that the fuel supply be provided by the project and the charge be included in the rent. — Delaware

Project Plants

SELECTION OF TYPE

There are three types of project-operated plants:

1. Central plants: furnishing the requirements of the entire project from a single boiler room.
2. Group plants: furnishing the requirements of the project from two or more boiler rooms (preferably equally sized and strategically placed), each serving a group of buildings.
3. Building plants: furnishing the requirements for the buildings in which boiler rooms are located, thus eliminating underground distribution lines.

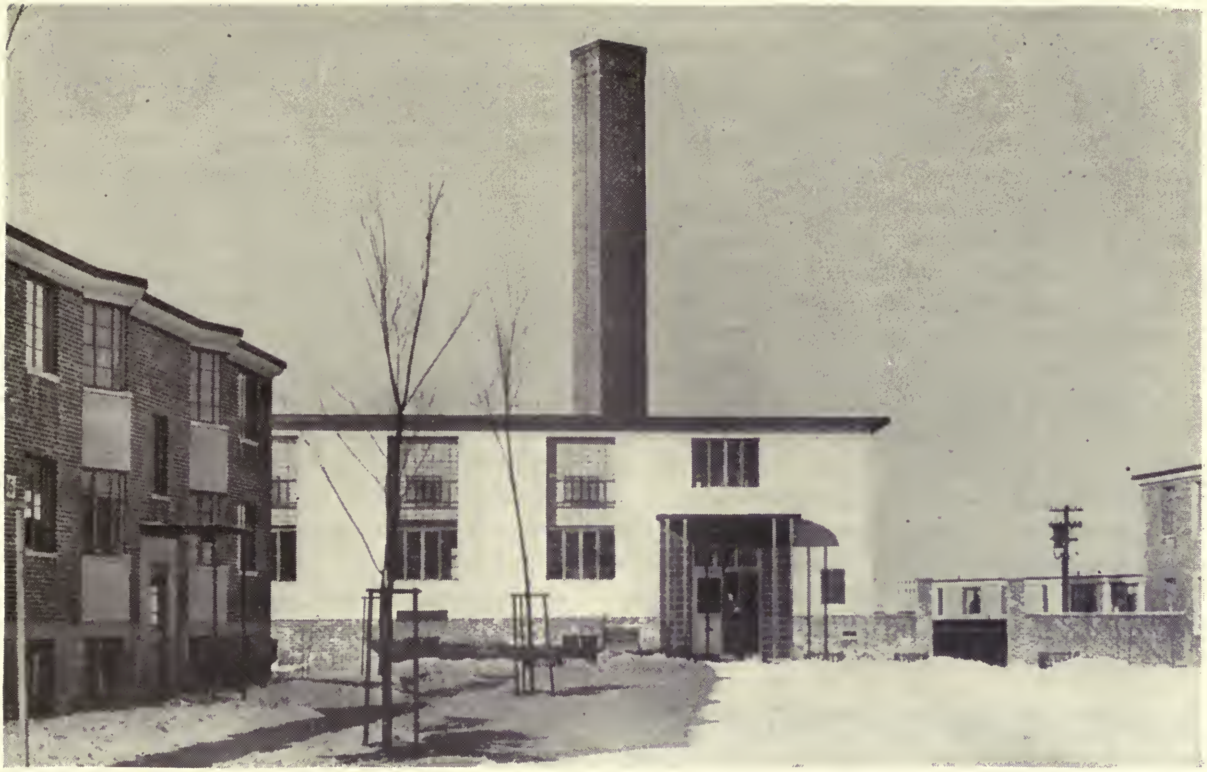
In addition to the three types of project-controlled systems, low-rent developments have sometimes been heated by steam purchased from a local utility company. The possibility of heating by purchased steam will be determined by availability and by comparative cost analyses.

The selection of a central plant, group, or building plant will be affected by:

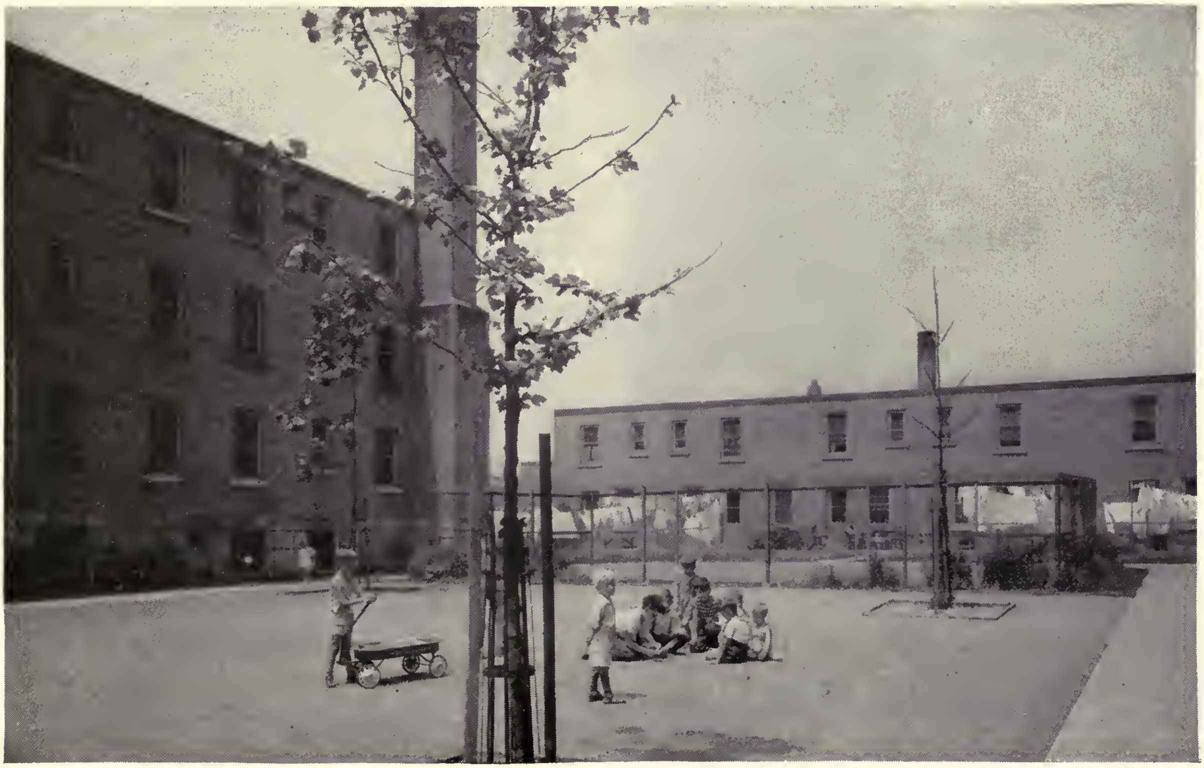
1. The arrangement of buildings, and the size and topography of the site. Normally the central plant offers the best possibilities for economy, but where a site is naturally divided into definite areas group plants have been chosen. However, because the same type of mechanical equipment is necessary in each boiler plant, group plants involve increased operating staffs and maintenance expense. Building plants seem advisable only in very large multi-story buildings.
2. The types of fuel economically available. Where coal is the cheapest fuel, over-all experience indicates that the central plant, stoker-fired, is a reasonable selection. Light fuel oils and gas require but little handling and burn efficiently and firing may be automatically controlled in small boilers. This, therefore, may make the selection of small group plants desirable. Heavy fuel oil can be burned most effectively in large boilers, making the large plant the logical choice.
3. Labor rates, labor regulations, and operating ordinances.

TYPE OF SYSTEMS

One-pipe steam systems have been found impracticable. No satisfactory automatic heat control for



The central heating plant stack is, naturally, conspicuous

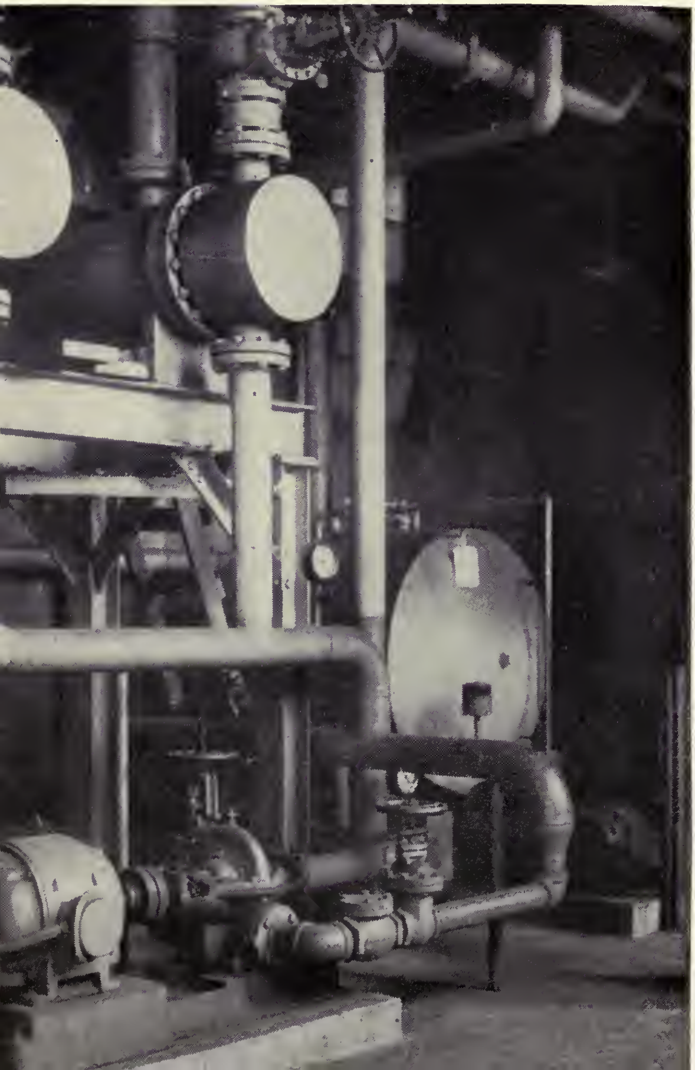


Group heating plant stacks may be scaled down somewhat this system is available, and operating expense is therefore usually higher than in two-pipe steam or in forced hot water systems.

Two-pipe steam systems with steam generated at low pressures ranging from 2 to 12 pounds gage have been those most extensively applied. The two-pipe system has been used also in the cases where steam is purchased from a utility company. High-vacuum systems have resulted in economical operation, being particularly effective in mild weather when little heat is necessary. The lower range of pressures is suitable for building plants and for other types involving a moderate system of underground distribution; higher pressures are suitable only where an extensive system of underground distribution is used.

Generation of high-pressure steam at 80 to 100 pounds gage is often necessary in central plants for low-density projects of 1,000 dwelling units or more. Generating pressures are reduced to 30—50 pounds for main (yard) distribution to machine rooms, then to 2—5 pounds for heating service, and to a minimum of 5 pounds for operating hot-water generators, unit heaters or laundry driers.

Heat exchangers



Purchased steam is delivered at high pressure (customarily 50 pounds gage or over) in a main provided by the utility company, generally terminated at a convenient metering point within the project boundary, where it is reduced to operating pressures for distribution to the various buildings. In unusually large projects it may be necessary to continue the high pressure line after metering to the various machine rooms, at which points the steam pressure is reduced for distribution to a group of buildings near the respective machine rooms.

Steam has also been used in connection with heat exchangers where the heating medium for the buildings is forced circulating hot water.

Forced hot-water systems have been designed to provide 200 to 240 Btu per hour heat transmission at the radiator. High transmission rates allow the use of small radiators. A one-pipe system has been effectively applied to small plants having a simple system of underground distribution; two-pipe systems are desirable in larger plants requiring extensive underground distribution. Forced hot-water systems do not need a crawl space under buildings since mains may be placed overhead.

The forced hot-water system, embracing underground distribution, is a logical selection for projects built in areas having a high water table. The reason for such selection is that the problem of pitching the lines to drips in steam systems, requiring extra underground depth for returns, does not exist in forced hot-water systems; raise-ups on returns running to receiving tanks are not practicable in steam systems.

Forced warm air has, in some cases, been supplied through a heat exchanger in each dwelling piped to a two-pipe forced hot-water system. The exchanger, integral with a motor blower unit and controls, is supplemented by a plenum chamber having ducts to each room. Some degree of heat control is obtained by modulating the hot-water temperatures. This type of heating used by one housing authority in the East was evidently selected in preference to a radiator heating system because of the absence of exposed piping and radiators. There is no projecting equipment to interfere with the furniture and only

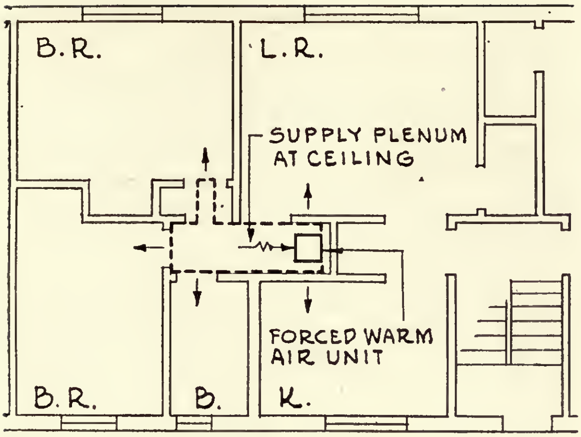


Figure 12. Heat exchanger installed in dwelling with plenum chamber at ceiling

unimportant interior space is occupied by this system. Operational and maintenance difficulties have been experienced. Since heating with this unit is no different from the ordinary forced-air system, the absence of a return duct system is strongly felt, particularly on the first floor, where air sweeping across the living room floor to the return grille mounted on the unit has a chilling effect. In the case of two-story buildings, the second floors overheat.

Because of dirt and lint accumulated on heat exchanger surfaces, heat transmission to the air is reduced and air flow is restricted. These deficiencies can be overcome only by increasing water temperatures with a consequent increase in the fuel consumption. Cleaning of exchanger surfaces is done with a vacuum cleaner. It is believed that with the addition of filters of the cleanable type, the performance will improve.

When units of this type fail to perform properly, tenants use gas ranges to augment heat. Higher air temperatures for comfort appear necessary also with this heating method because of the absence of direct radiating surfaces.

PIPING SYSTEMS WITHIN BUILDINGS

Mains feeding radiators are run in basements, crawl spaces, or within dwelling units exposed under the first floor ceiling along the approximate center of the building. Sectionalizing the distributing mains by means of stop valves will permit repairs on any one section without shutting down the entire system.

The latter method has been used by some housing authorities. A single steam supply line feeds up and down to radiators located along the inside walls. The return main is run in the crawl space. This method, although apparently cutting down the cast iron radiation load, has tended to pocket a blanket of warm air at the first story ceiling and has kept the second floor uncomfortably warm. Rooms on the second floor are thus overheated in mild weather. Also, the ceiling above the heating lines is blackened by the accumulation of dust. Radiators along the inside walls near the center partition have caused cold spots in the rooms. An otherwise good heat distribution system has thus been sacrificed for savings in piping and initial costs.

Expansion in piping can be taken up by swing joints, expansion joints (mechanical type) and pipe bends. For long runs of pipe, especially in lines operating in excess of 15 pounds gage steam pressure, the pipe bend has proved best because it involves no maintenance or renewal problems.

Vacuum vent valves on the return mains of a two-pipe steam system with condensate pumps have eliminated the water hammer experienced during the heating-up period in early morning hours.

Some trouble developed on a large multi-story project because the drip traps for the two-pipe steam system were too small. Operation improved after the traps were replaced with larger ones.

Air binding of radiators fitted with top and bottom connections on the same side in an up-feed hot-water heating system was experienced by one housing authority. The binding could have been eliminated to a great extent by bottom-bottom connections, although the cost of this type of connection is higher when both supply and return risers are on the same side of the radiator.

To overcome difficulties sometimes encountered in piping installations, at least three feet from crawl space floor to underside of concrete floor or wood floor joists is necessary. Minimum headroom from underside of pipe or duct in dwelling or non-dwelling spaces such as social rooms, offices, and basement traffic areas should be 6′-3″.

> We heartily recommend hard surface to all spaces underneath dwelling units; also that at least a six-inch clearance be given piping adjoining or adjacent to underneath framing. There are numerous instances where the piping is so close to beams and floor construction above that it is almost impossible to use a wrench. — Regional Report

PIPING SYSTEM OUTSIDE OF BUILDINGS (UNDERGROUND DISTRIBUTION)

The underground distribution system should be correlated with building arrangement. Consultations with the housing authority in the early stages of design to find out whether additions to the project are contemplated will help to avoid placing pipe lines in the way of future buildings. It is good economy, also, to provide for future loads in sizing pipe.

Since materials are to be installed where repair or access is difficult, experience prescribes that extreme care be exercised in the selection of appropriate materials. Steel pipe is satisfactory for supply lines in steam systems and for supply and return lines in hot-water systems. A more corrosive-resistant material is preferable for return lines in steam systems because of the destructive action caused by water and air flowing in these lines.

Conduits, concrete trenches, and tunnels are means employed for housing underground piping. Tunnels are the most expensive of the various systems of housing pipe and cannot be considered for low-rent projects. However, when it is necessary or expedient to provide tunnels for passage between buildings pipes can be located in them.

Some destructive effects of dampness on the insulation have occurred on lines placed in concrete manholes: this defect has been overcome by providing for additional ventilation in the manholes.

An underground distribution system may be elaborate or simple, depending upon the method employed in routing the lines. The provision of

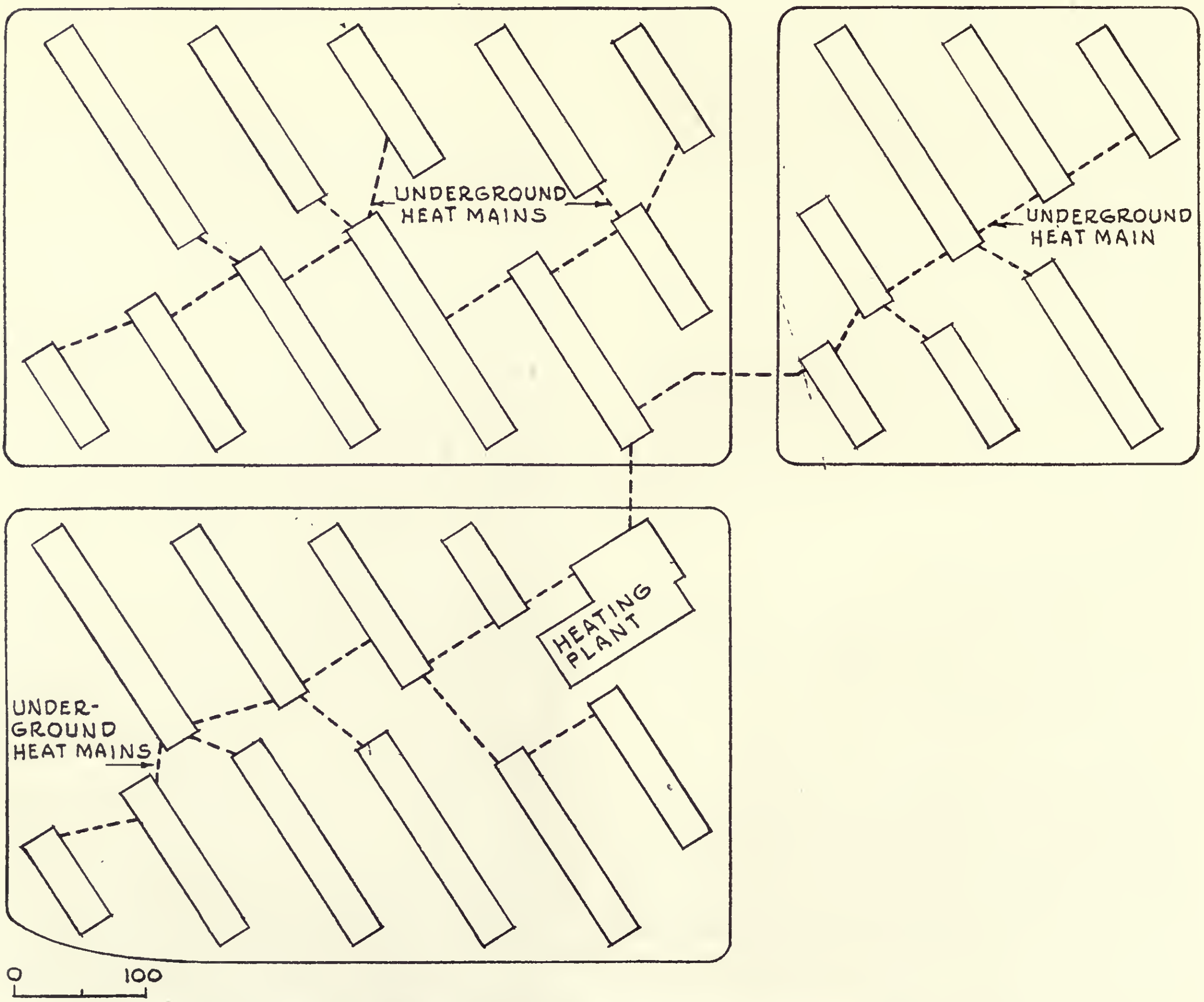


Figure 13. Underground piping layout with provision for expansion in the buildings

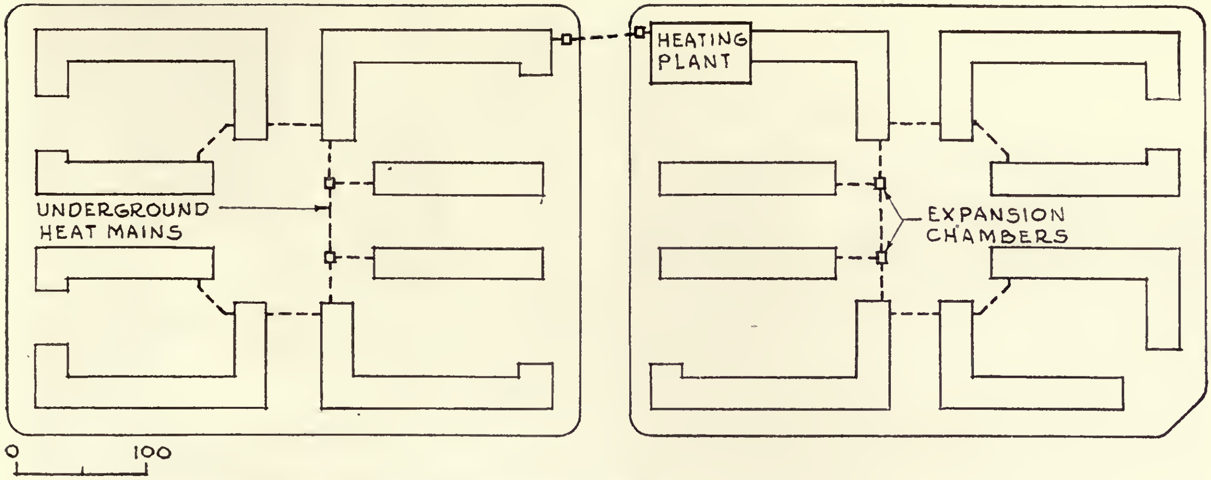


Figure 14. Underground piping layout with expansion chambers

means for pipe expansion in the yard involves masonry chambers or manholes which are costly to build; routing the lines directly from building to building will permit pipe expansion within the buildings and will avoid, as a rule, the need for building such chambers or manholes. Expansion is best taken up by pipe bends or loops; exact guiding is necessary to avoid rupture where mechanical-type joints are used.

Noise in high-pressure steam lines passing through buildings has sometimes disturbed tenants. This noise may be caused by a trap sticking open and blowing live steam to the condensate return. Discharging the drip at each trap to a vented flash tank should overcome this trouble.

BOILER AND MACHINE ROOM DESIGN

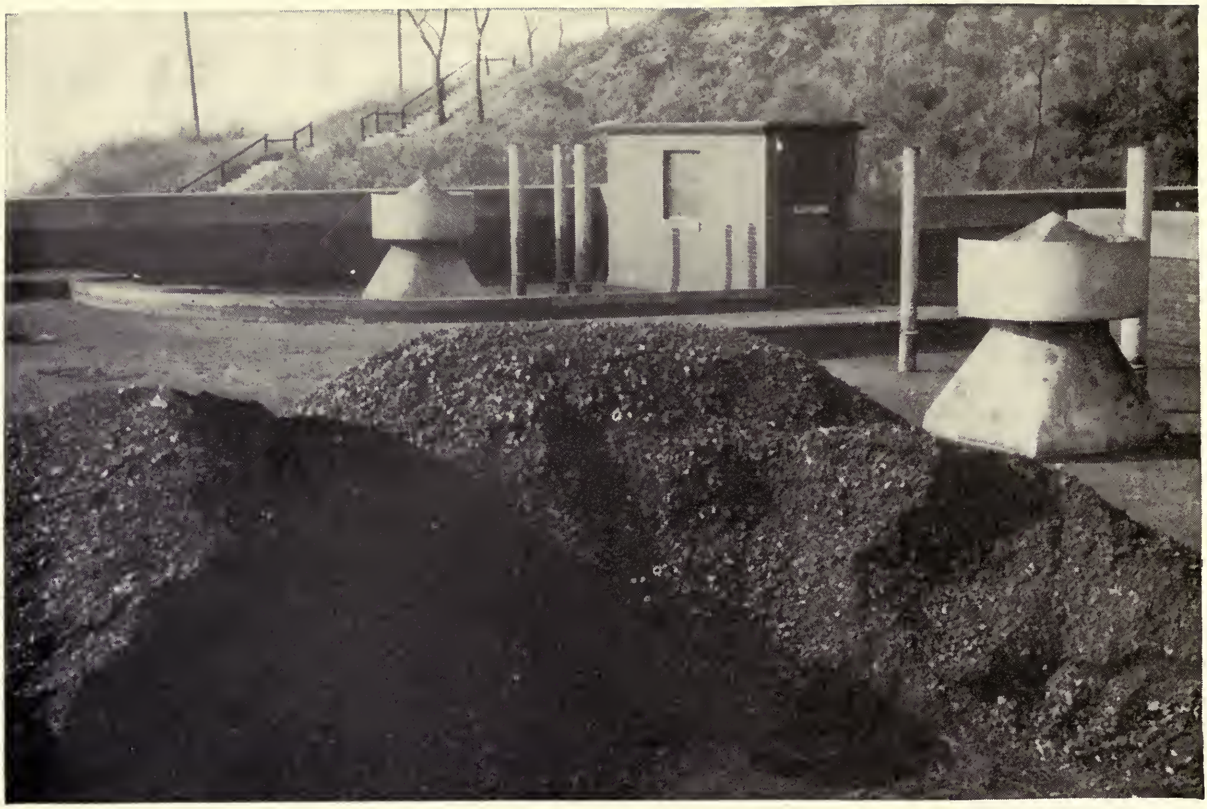
Boiler room space in some instances has been so restricted as to hamper operation, and where conversion to coal from other fuels has been necessary the cramped space has caused trouble.

It is important that equipment be planned carefully for the best use of space, for possible changeover to coal from other fuels, and for expansion of the plant where there is reasonable assurance of project expansion. Adequate natural ventilation is essential to assure efficient combustion of fuel and proper functioning of control instruments (such as water temperature regulating valves). Instruments with delicate mechanism are subject to false operation caused by excessively high temperatures ambient to the instrument mechanism. Easy access to equipment, especially boiler tubes and coal stoker ram or screw for servicing and replacement is also necessary. Boiler tubes have been made easily accessible for cleaning from a movable platform.

> Heater room is not well lighted, and it would be necessary to take down part of coal room wall to remove worm gear of stoker. — North Carolina

It is good policy to take advantage of a sloping terrain for boiler room construction, particularly for

Coal-fired plant on a steep site



Grade permits coal trucks to drive on to the roof above coal storage

coal-fired installations. Such an arrangement will obviate extensive coal handling equipment. An ideal layout is to have the coal trucks drive on to the roof of the coal storage and dump the coal directly into the bunker through manholes. Arrangements for dumping coal from grade level to underground storage are quite commonly found.

Usually space for at least ten percent of the estimated annual coal consumption is advisable. Oil storage of not less than a ten-day supply for coldest weather has been found to be a good practice. But if sufficient savings can be realized to warrant the extra storage facilities, it is wise to provide space for carload purchases either of coal or oil. For underground storage about two-thirds of the total storage volume should be filled without hand trimming.

The coal bin requires trimming of the coal after one load is put in from a truck. — West Virginia

Items to consider when locating chimneys are, first, that the passage of smoke on to adjoining buildings be reduced as far as possible, and second, that the boiler room be kept at reasonable distances, say about 75 feet, from trees higher than the proposed chimney.

Machine rooms may be required in connection with large central plants. Located at strategic points, they generally house the domestic hot-water generators, pumps, heat control valve in steam systems, and, in high pressure system plants, the secondary pressure-reducing valve. Here, as in boiler rooms,

Coal is dumped from grade to underground storage careful planning for maximum utilization of space, adequate natural ventilation and protection from dampness is necessary.

Uncomfortably warm floors in dwelling units, social rooms, or offices directly over boiler or machine rooms have been a source of complaints from tenants. An insulated ceiling in boiler or machine room or a suspended ceiling forming a plenum, with air circulation through the plenum, will alleviate this condition.

BOILERS AND AUXILIARIES

Boilers and auxiliaries for small plants can be housed in the basement of a typical dwelling building or preferably, if the boilers are coal-fired, in the community or management building, to keep coal and ash dust away from the dwelling areas. A separate building need be considered only for large central plants.

In sizing boilers it is desirable to consider only the total maximum load equally divided with all boilers operating. Spare boiler capacity for the rare occasions when one boiler fails during peak demands is not justified since boilers are built to take up loads in excess of their design rating for short periods of time.

The boiler room in the dwelling basement

The boiler room adjacent to management offices

Where boiler room locations in group plants permit it is advantageous to interconnect main distribution lines in order to use only one of the plants during the off-heating season, or during mild heating season weather, or in the event of a breakdown.

Designers have sometimes taken advantage of a low point on a sloping site for the boiler plant in steam systems. In such cases the condensate can return by gravity to the pump receiver placed in the boiler room, and the equipment is concentrated in one location. Pumps set on properly insulated foundations do not telephone noise to dwellings. Damage to the motor has resulted when pumps were placed in pits without waterproofing or in pits with walls so low that water could enter. Circulating pumps in hot-water heating systems installed so that boilers or heat exchangers are on the pump suction side should allow lower operating pressures on the boilers or exchangers.

Domestic hot-water generators that can be placed in boiler rooms rather than in machine rooms will avoid heating long runs of underground distribution lines during the off-heating season. Keeping such lines hot for the sole purpose of operating generators results in considerable line losses in proportion to the total plant load, with unnecessarily high fuel consumption.

Coal stoker selection will depend upon the size of boiler and type of coal to be used. The underfeed stoker of the ram, combination of ram and screw, or screw-feed types generally are suited to the typical project plant.

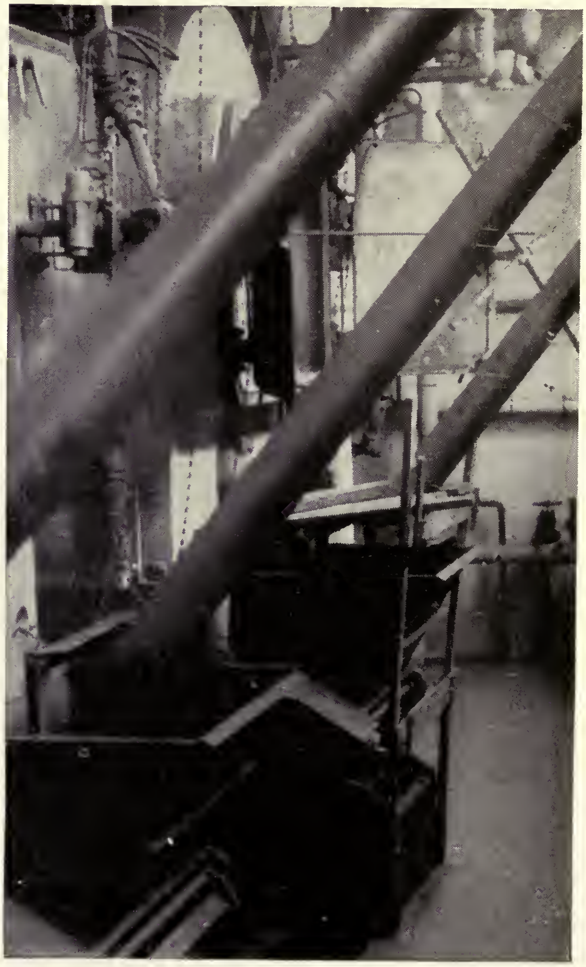
The travelling chain grate and the overfeed (spreader type) stoker have been successfully used with large boilers in areas where low heat-value coals are available. Extra combustion space is essential for the spreader type of stoker; a cinder trap in the breeching is usually required in connection with this equipment.

The travelling chain grate stoker has been adapted to burn small sizes of anthracite such as barley. Periodic operating trouble has occurred, particularly during the summers when the load is very light and it is necessary, consequently, to have a thin fuel bed. An ignition arch built over the entire area has been found to improve operating performance.

Coal and ash handling machinery or equipment prudently selected and appropriate for the size of plant and arrangement of boiler room will reduce operating expense. Wages constitute a large part of the expense in the operation of coal-fired installations.

The normal elevating machinery can be eliminated in connection with overhead coal storage if, as previously stated, boiler room buildings are constructed on ground slopes so that coal trucks can drop coal from roof to bunkers. Equipment appropriate to the type and size of plant is often necessary, however, to convey coal from storage to stoker hoppers. Typical methods of conveying coal to stoker hoppers are (1) a coal bucket mounted on a monorail, (2) a travelling weigh larry, or (3) a direct chute from storage to the hoppers. With bin feed stokers, the coal is fed by stoker operation from bin to boiler. Wheelbarrows are adequate for the smaller plants.

Handling costs have been cut in plants burning anthracite barley coal by the use of a motor-operated conveyor mechanism enclosed in a steel casing.



Coal is chuted directly to stokers

This conveyor loads from the coal storage without feeders and discharges at the head end of a vertical run directly to the stoker hopper. The only manual labor necessary is for raking ashes into cans and carting the cans to a hoist for elevation to street level or ash truck.

A typical method of ash handling is the hoist, manually or electrically operated (the latter is economical for larger plants). In high-pressure steam plants, a system of conveyor piping operated by steam jets (vacuum type) has been applied.

One housing authority has a way of conveying the ashes directly from boiler pit to truck. A deep ash pit is provided under each boiler, large enough to hold approximately a week's supply of ash. Piping extends from boiler pit to the outside of the building wall; a flexible hose is connected from the wall outlet to the truck. The truck is equipped with a storage bin and is fitted with a pneumatic exhausting mechanism which requires two operators. The mechanism operates noisily and can be heard in nearby buildings. Furthermore, unless machine parts can be duplicated or easily repaired, this scheme of ash disposal may prove unsatisfactory, since delays would involve excessive ash accumulation.

Oil burner selection will depend upon the size of boiler used. Those designed to burn the lighter oils can be used for the smaller fully automatic plants, whereas the burners designed to operate with heavier oils (Nos. 5 and 6) are most commonly used in the larger plants.

Gas-burning units integrally arranged with boilers designed specifically for gas are desirable when the utility analysis shows that gas is the most economical fuel, and where a survey shows that competition with other fuels is remote. Gas-fired boilers located at hot water generator stations for heating domestic water during the off-heating season may be advisable for large central plants burning coal or oil, especially where the local utility company offers a "dump" rate: here again comparative analyses of costs and expenses between this method and that of supplying hot water from the central plant is necessary.

The benefits of boiler plant instruments installed to regulate operation can only be realized when plant personnel are trained in the correlated value of each instrument and taught to take full advantage of and to appreciate the significance of each instrument. Soot blowers installed on large boilers burning bituminous coal or heavy oil will effect saving in fuel consumption.

FEED WATER TREATMENT

Experience with average boiler feed waters has shown that they cause scaling, corrosion and pitting of piping and boiler tubing. The prompt and judicious application of chemical treatment tends to eliminate these processes and to extend the life of the equipment. It is necessary to provide some means of injecting the correct chemicals into the piping system.

As the type of treatment will vary with results shown by a water analysis, the problem is a specialized one. Local utility and other companies operating boiler plants in the project area may be consulted for their experience in analysis and treatment of local waters. The services of an independent water-analysis laboratory may be necessary. For federally owned or operated projects, the Bureau of Mines may be called upon for assistance.

The Bureau of Mines has prepared a booklet on boiler feed water conditioning[1] and has developed a test kit, with instructions for its use, as a simple means for testing feed water.

HEAT CONTROL

The necessity for an accurately designed heat control system cannot be too strongly emphasized since only by such controls and by their effective co-ordination with outside temperatures can fuel savings be realized and tenant comfort attained.

The steam system controls generally applied are the "continuous flow" or the "intermittent" types. The system for large plants is divided into a number of sections of approximately equal heating loads with a separate control valve for each section, electrically or pneumatically operated, usually actuated by a thermostat responsive to outdoor temperatures.

Forced hot-water system control usually regulates the water temperature (governed by outdoor temperatures) by means of an electrically operated valve or valves connected to supply mains and return mains. This by-pass arrangement (functioning on the mixing principle) is apparently simple and satisfactory; water leaving the boiler or heat exchanger

---

[1] Questions and Answers on Boiler Feed Water Conditioning. J. F. Barkley. Government Printing Office, 1936.

A well-placed thermostat

is maintained at constant temperature, but variation in temperature of water supplied to the system is dependent upon quantity of flow from main supply and by-pass, respectively.

The outside thermostat has sometimes been placed where warm air currents from open windows in boiler room or machine room, or from other sources, have affected the correct functioning of the temperature control. It is wise to place the control where it cannot be tampered with.

Improperly sized orifice plates in radiator valves have resulted in unequal heat distribution and consequent fuel waste. Tenants have been known to experiment with adjustments in valves or with orifice plates; it may therefore be expedient to wire or seal such plates.

In two housing projects in an East Coast city, both having forced hot-water systems, the radiators of one project are balanced by means of a pierced plate in each radiator supply valve, whereas in the other project balancing equally effective is accomplished by a union elbow with a simple balancing feature on each radiator.

An apparently successful method of balancing a forced hot-water heating system tried by one housing authority, provides and maintains a pressure differential between supply and return mains in each building with fixed settings of lock shield valves. The balancing feature originally fitted in each union elbow on radiators has been readjusted to full open position.

LAUNDRY DRYING ROOMS

The comparative cost analysis should determine the method of drying and type of equipment. The following methods should prove to be satisfactory:

1. Steam or gas-heated cabinet drier, properly vented and installed in a well-ventilated room.
2. Drying compartments with warm air supplied near the floor from a unit heater automatically controlled and arranged for adequate ventilation.

When supplied from the heating system, it is desirable to locate rooms near a constant source of heat supply to avoid unnecessary heating of long supply lines.

Gas cabinet drier

Tenant Plants

When tenant plants are chosen there is need for engineer and architect to work closely together. Low-rent dwellings are not spacious; heating equipment has sometimes been placed in such cramped quarters that firing and repairing them is unduly difficult; the position of radiators, heat risers, registers, and grilles often has interfered with the use of wall space. Adequate ventilation of spaces for boilers, furnaces or even space heaters is needed for efficient fuel combustion. Attempts to adapt a particular heating system to units planned for other systems have not been entirely successful.

> Heater location and layout: This subject has received more criticism than any other heat complaint in this region, particularly with space heaters. Plans often completed without any consideration of space heater location — added afterwards. — Regional Report
>
> Stricter co-ordination of architectural and mechanical designs might have resulted in a more efficacious location of heater. — Georgia
>
> Oil fired space heaters completely unsatisfactory for two-story units, okay for one-story units if doors to bedrooms are left open. The open grilles over bedroom doors are ineffectual except for preventing any one from having privacy. — Virginia
>
> Difficulties have been experienced with air distribution, apparently when furniture has been placed directly against return registers. — Ohio

Care in selecting simple, tamper-proof controls will be rewarded, as will thought spent on their location and their accurate setting. The need for simple controls on space heaters is also felt where tenants are supplied with gas fuel.

> Automatically controlled gas-fired hot-air furnaces, as used in western Pennsylvania projects, are considered entirely satisfactory. Tenants should be educated to the fact that these units are very delicate and should not be tampered with. All controls should be enclosed by the manufacturer and a lock placed thereon. — Regional Report
>
> Simplified thermostatic and time control of space heaters desired. — Georgia

TYPES OF SYSTEMS

Radiator systems (one-pipe steam and two-pipe hot-water), warm air systems (forced and gravity) and space heaters (circulators, above-the-floor type) are the three types of tenant plants most often found in low-rent housing.

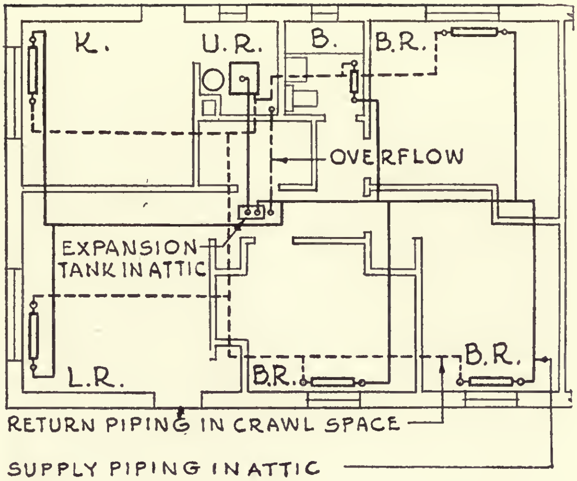


Fig. 15. Gravity hot-water system with an open expansion tank

One-pipe steam systems are lower in first cost than gravity hot-water systems, but less easy to control and less economical of fuel. If the basement is to be used only for boiler installation and fuel storage it is fair to add its cost to that of the system.

Hot-water systems with well placed low radiators have generally produced low temperature gradients from floor to ceiling, and can be regulated to produce a moderate but steady supply of heat. The system most often used has been the gravity open type so designed that hot water is piped from the boiler (located on same floor as the dwelling) through an expansion tank placed above the highest point in the system, and is then recirculated to the boiler through a system of supply piping, radiation and return piping. The closed tank type has been used to advantage in flat roof dwelling construction, in which case the expansion tank is located directly above the boiler. The boiler may be placed in a corner of the kitchen or, preferably, in a separate utility room; an insulated main located under the ceiling will blacken the ceiling.

Coal has been the most usual fuel for radiator systems, principally because of economies in first cost and in operation. If the dwelling has no basement, tenant convenience is served and project repainting work is saved by keeping coal- and ash-carrying away from the principal rooms as much as possible.

> Coal-fired hot-water heating system seems to be the most satisfactory of all systems, and very few changes can be recommended. — Regional Report

Cooking, space heating and hot-water heating are here combined

A triple-service coal fired unit has been installed by a housing authority in two of its projects. This unit is approximately four feet long, two feet wide and three feet high, and consists of (1) boiler feeding hot-water radiators, (2) insulated cooking range, (3) water-back inside the cooking range for heating domestic water. The boiler and range are separately fired and housed within a porcelain-enameled casing. The assembled unit is placed in the kitchen.

The forced warm-air system is frequently used. Gas and oil fuel are well adapted to this system because a more central and therefore more effective location can be chosen for it than for a coal-fired furnace since the latter, like the coal-fired boiler, should be away from living spaces. If the dwelling has a basement, a coal-fired gravity warm-air system can be used to advantage.

It is recommended that basements be constructed in future buildings which would house the heating unit and coal bin. — Ohio

Return air ducts (particularly in first floor rooms) have proved to be well worth their installation cost because of reduced temperature gradients; and they may be considered indispensable when first floors are built over unheated crawl spaces. In any case the floors must be well insulated.

Tenants complain of inadequate heating systems. In design give more attention to (1) location of supply

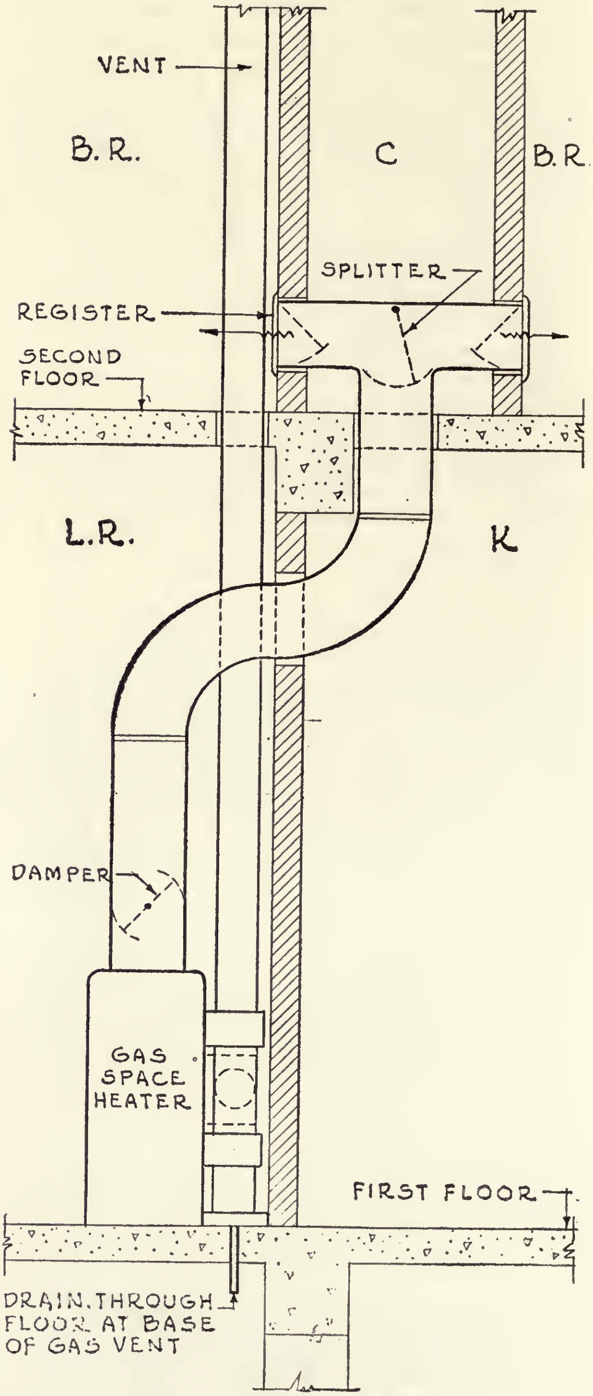


Figure 16. Detail of duct from gas space heater to second floor registers

The space heater is particularly adaptable where the heating season is short

and return ducts, (2) insulation of floor. Hot-air ducts near base of stairs, unsatisfactory. — Regional Report

Forced warm-air heating systems, though fairly satisfactory from heating standpoint, present following problems: Power requirements high; tenants use blowers in summer; high motor repairs and replacement; redecorating costs increase where filters are not used. — Regional Report

Forced-air heating system and ducts found excellent by management and tenants. — Connecticut

Heating system coal fired, forced warm air, recirculating. Efficient, but as in other projects, first floor heated to 78° – 84° at head height in order to offset definitely drafty, uncomfortable floors. — Pennsylvania

Space heaters have been used with complete satisfaction in many projects, notably where the heating season is short and mild and (as in parts of California) where the need for heating is intermittent. The most common type is a gravity heater fitted with an outer casing which surrounds the heat exchanger surface. Since its effective heating radius is approximately fifteen feet, the heater is placed near the center of the dwelling, preferably in the living room. Here also, a well insulated first-story floor helps the heating system.

Sometimes, in two-story houses, a simple duct arrangement has been flanged to part of the top heater grille and then carried through a second floor closet and connected to valved registers (directly above the floor) in two bedrooms. A volume damper and a splitter control the passage of heat. This system works particularly well with the large grille of a cabinet-style gas-fired heater.

Space heaters adequate. — North Carolina

Space Heaters: Further south, O.K. because needed for only a short time. Wilmington, N. C., either borderline case or too far north to get adequate heat in the bedrooms; particularly in three-bedroom house — it means the living room is much overheated. — North Carolina

A fireplace with heating grilles may be used in mild climates

Fireplaces with built-in warm-air circulation have been used in some Gulf Coast cities.

The gas-fired gravity floor furnace suspended from the floor construction has been very little used. When located in the hall space centrally within the dwelling unit this method will give a more uniform temperature distribution than the floor-mounted circulator. Disadvantages however are (1) inaccessibility for effective maintenance, (2) water within crawl space backing up into furnace, and (3) high floor grille temperature. The second disadvantage may be overcome by a waterproof pit, and the third disadvantage may be overcome by the dual wall register type of floor furnace. However, for practical purposes the same over-all comfort could be maintained with the circulator at a smaller initial cost.

One project in the East has installed an adapta-

Flue from ceramic heater also warms rooms on second floor tion of the European ceramic stove (Kachelofen) built of glazed brick and tile. The heater is coal-fired; its performance is satisfactory when the tenant understands its operation. The principal disadvantages, apparently, are the heat lag and the long cooling-off period, which seems to indicate that it can best be used in climates where temperature changes are gradual.

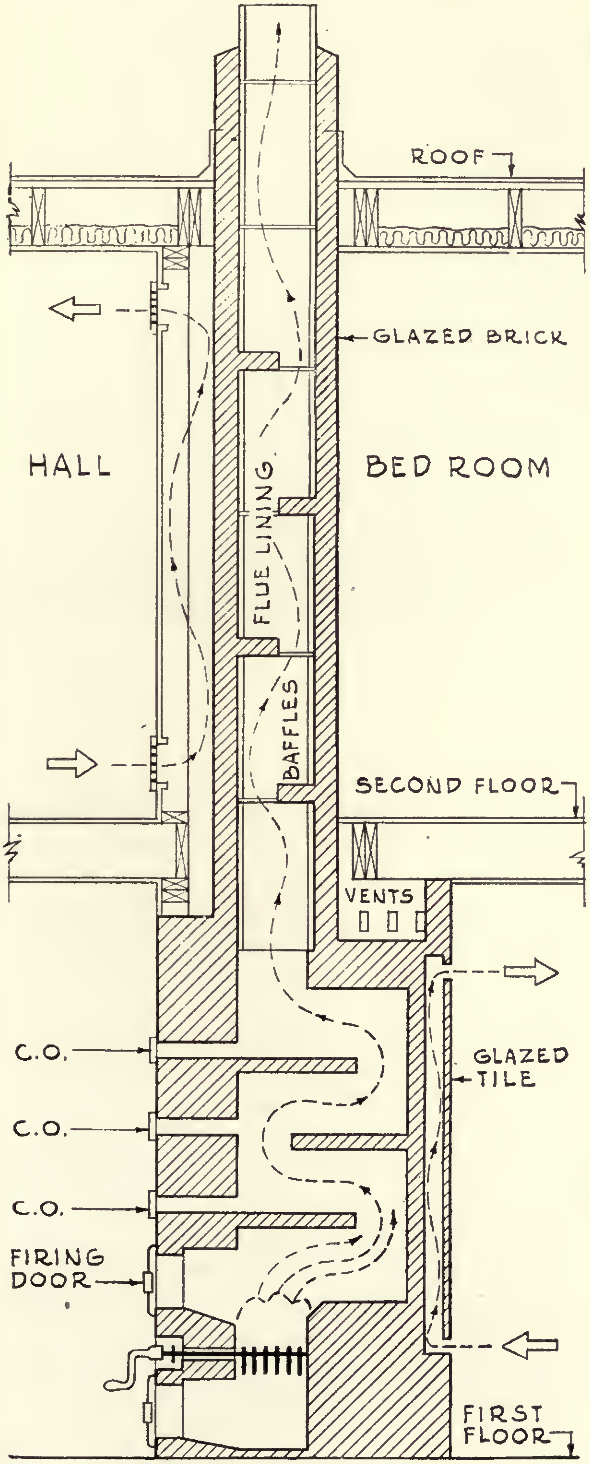
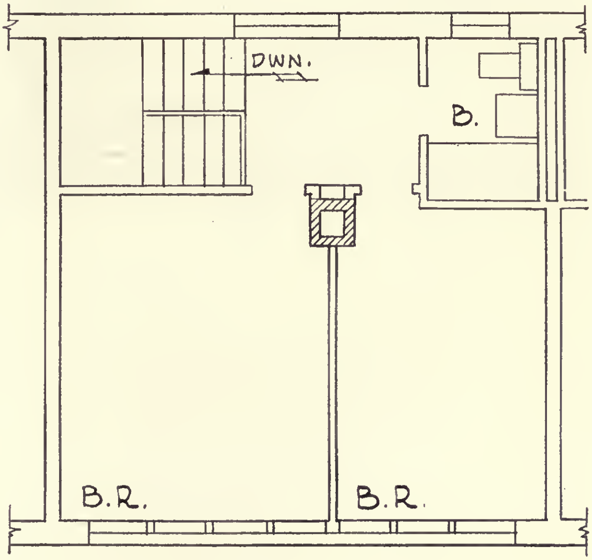
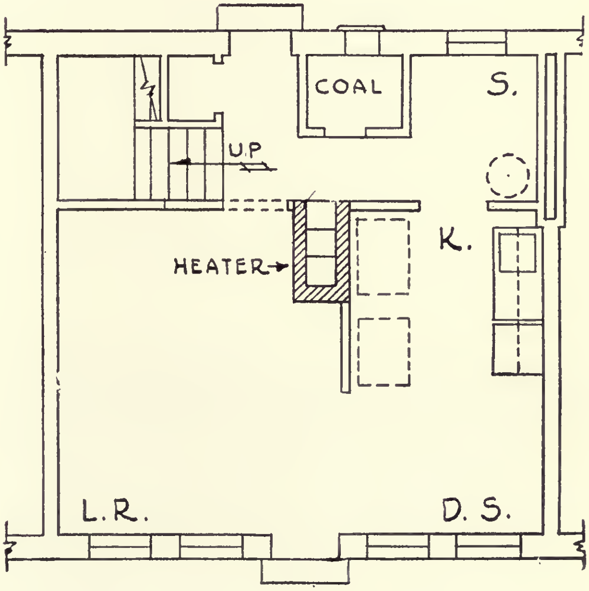
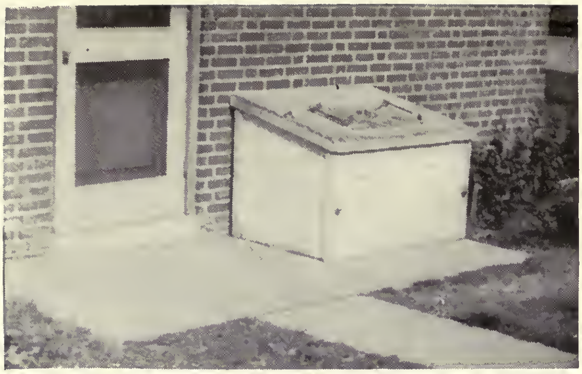


Figure 17. Detail of ceramic heater







Concrete coal box lids are heavy

FUEL STORAGE

Coal can be stored in individual outside bins constructed of concrete with a wood cover, or entirely of wood (preferably the former). This arrangement is used when no basements are provided. In many cases, particularly in the colder areas, coal bins have been made so small that tenants were obliged to purchase odd lots of coal at a high rate. It is good policy to allow enough storage so that the tenant can secure at least one ton before his supply is depleted. Location of the bin is also important. See "Fuel Delivery and Storage" in "The Site Plan."

> Wooden coal boxes are unsatisfactory. Concrete boxes should be provided. Precast boxes are satisfactory but the heavy concrete cover should be replaced with a light wooden lid. — Regional Report

> No outside storage space for kindling. — Regional Report

Oil can be stored by one of the following methods:

Storage for kindling is always needed where coal is used

1. A tank of a few gallons capacity mounted on the equipment. The tenant fills the tank from a separate container.
2. As in the preceding, with the addition of steel tanks of 55- or 110-gallon capacity with a locking-type spigot, placed directly outside each dwelling, or in groups on the project, where the tanks can be filled by hose from the tank truck.
3. Oil piped directly to the equipment from a 55- or 110-gallon tank (preferably the latter) placed outside the dwelling unit. This scheme is feasible where more than one piece of equipment in the dwelling is oil-fired, or where the heating system is a more extensive one than a space heater (for example, forced warm air). Tanks mounted on the equipment are not needed. In some cases the tanks are secured to the building. On other projects the tank is mounted on a cradle.

The second or third methods permit group purchases of oil in large quantities and will reduce fuel cost.

Another scheme that could be more widely applied than it has been in the past is that of having the project provide oil in tank-truck lots stored in large underground tanks, each tank serving a group of tenants. The oil would then be piped to the individual equipment through a metering system.

CHIMNEYS, FLUES AND SMOKE PIPES

The masonry chimney lined with flue tile seems to be the all-purpose chimney. In localities such as California, however, where gas is commonly used and other fuels are not competitive in price, a flue suitable for gas burning equipment only such as "cement asbestos", or other patented types, has been installed.

A porcelain-enamel metal flue, surrounded with insulation and designed for use with all fuels, has been developed. In its use careful workmanship, selection of insulation suitable for the service intended and adequate clearance between insulation and combustible construction are essential in order to prevent potential fire hazards.

Smoke pipes, in order to prevent fire hazards, must be kept at a safe distance from all combustible construction or material; must not run through closets, and should be connected to chimney flues in short, direct runs to obviate draft restriction and to minimize replacement costs.

Electrical System

EXTERIOR DISTRIBUTION OF LIGHT AND POWER

Factors influencing the choice of fuel and energy for lighting, refrigeration and cooking, etc., are discussed in the chapter, "Selection of Utilities."

Load characteristics are the determining factors for intelligent design of the distribution system. A project load consisting only of lighting creates a poor load factor. The addition of a 100 percent saturated refrigerator load greatly improves this factor. The addition of a 100 percent range installation will tend to create a poor load factor. It is important, therefore, in designing the distribution system that consideration be given to the heavy loadings for short durations caused by the type of equipment served.

If the rate classification under which the project will be served penalizes the project because of a low power factor it may be desirable to correct the power factor by installing a capacitor, providing the investment cost and maintenance expense do not offset savings that can be effected by creating a unity, or near-unity, power factor. A recent check on a project of about 300 dwelling units indicated a 75 percent power factor with a lighting and refrigeration load. An investment of $1,000 for a capacitor resulted in an annual saving of $1,500. The local utility company should be consulted on matters of power factor correction.

Individual forced warm-air heating systems utilizing a motor for operating the fan contribute to the power factor problems, particularly if motors are overloaded.

Overhead Versus Underground. The choice of an underground system merely for esthetic reasons is seldom justified for low-rent housing because of the greater cost. Occasionally a section of the distribution system may be underground: sometimes overhead and underground combined is desired—for instance, an overhead transformer station with underground primary conductors and overhead secondary conductors.

Important factors affecting the selection of an overhead or underground distribution system are:

1. Type of existing systems surrounding the project and the trend in the replacement of such systems.
2. Contour of the project and water level; extent of interference by trees and playgrounds.
3. Safety factor, depending upon location and voltage of overhead lines.
4. Severity and frequency of electric storms, sleet, and ice formations and wind velocities.
5. Soil conditions: The presence of rock will increase cost of underground work; soil of low bearing value and high water content may cause difficulties with underground transformer vaults and manholes.
6. Comparative costs: An underground system will cost more per foot than an overhead system. Where a site plan lends itself to a comparatively short underground system, in contrast to a longer overhead system, the cost of underground distribution may compare favorably with the cost of overhead distribution.

In the interests of better appearance and lower maintenance costs, it is recommended that service wiring in the project be completely underground. — California

Types of Systems. The radial type is the simplest form of distribution and may be considered the most practical for low-rent housing developments. Although it lacks flexibility and does not offer insurance of service continuity, it may be used if topography and the arrangement of load are advantageous.

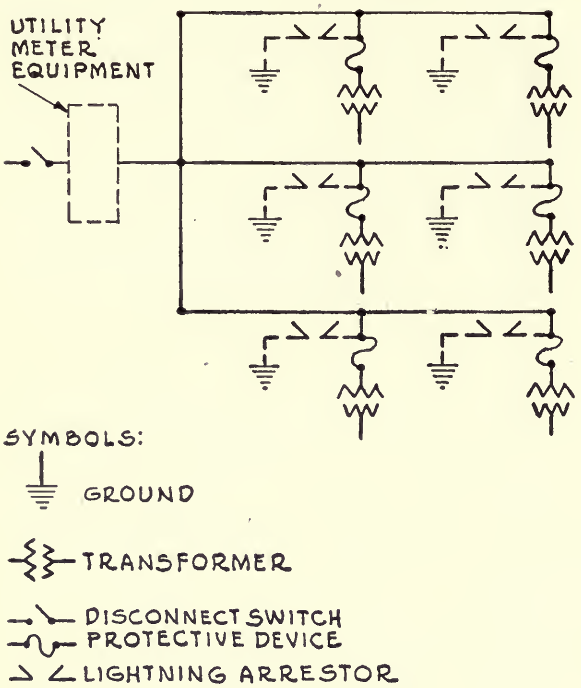


Figure 18. Radial system of distribution

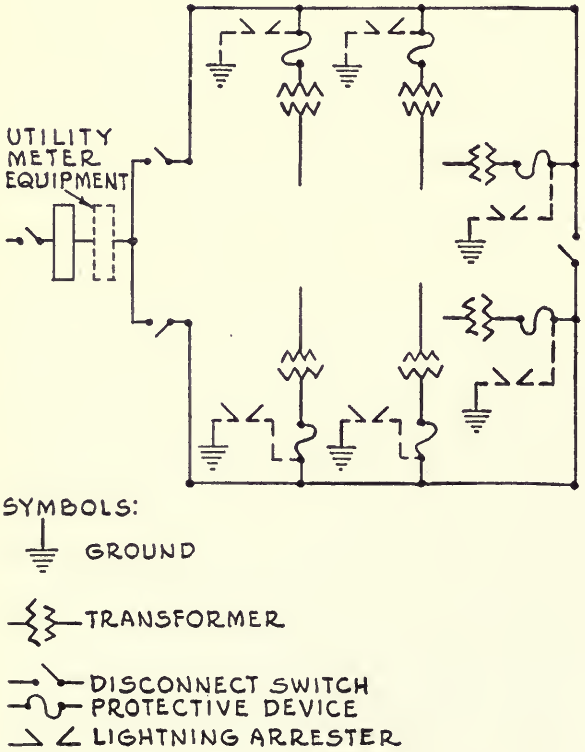


Figure 19. Loop system of distribution

The "ring" or "loop" system has greater flexibility than the radial system and is therefore often preferable. A simple loop line either for overhead or underground distribution with means for disconnecting the loop at its midpoint, as shown in the illustration, has been found to be satisfactory and economical.

A more elaborate loop system, with sectionalizing switches or disconnecting potheads at each transformer station, that allow by-passing of the station or feeding from either side of the loop, has definite advantages where a feeder outage, even of short duration, may result in accident or loss of life. The cost, as a rule, prohibits such an installation in low-rent housing.

Modifications of radial and of loop systems can be applied to meet local conditions and requirements. Simplicity in design and operation contributes to low maintenance costs.

Generating Equipment. Comparative studies of utilities may show that the generation of energy is less expensive than the purchase of energy. Available fuels will determine the form of motive power such as (1) high pressure steam driven units in connection with central heating plants, (2) Diesel engines and (3) gas prime movers. Each project will require individual study with respect to plant size, capital cost, operating expense, and general layout.

Local Utility Hook-ups. Points of contact with the utility company lines will be determined on the basis of negotiations with the utility company. The most common practice is a single point of contact with a master meter at that point. Several points of contact each with a master meter will contribute to lowering distribution costs within the project; it is important, however, that permission for totalizing the readings of the watt-hour meters be obtained so that the total consumption may be billed at the rate classification extended.

OVERHEAD EQUIPMENT

The overhead method of distribution may be accomplished by means of stringing conductors on pole structures and extending service conductors to buildings, or by stringing conductors on the building structures, looping from building to building, or by combining these methods.

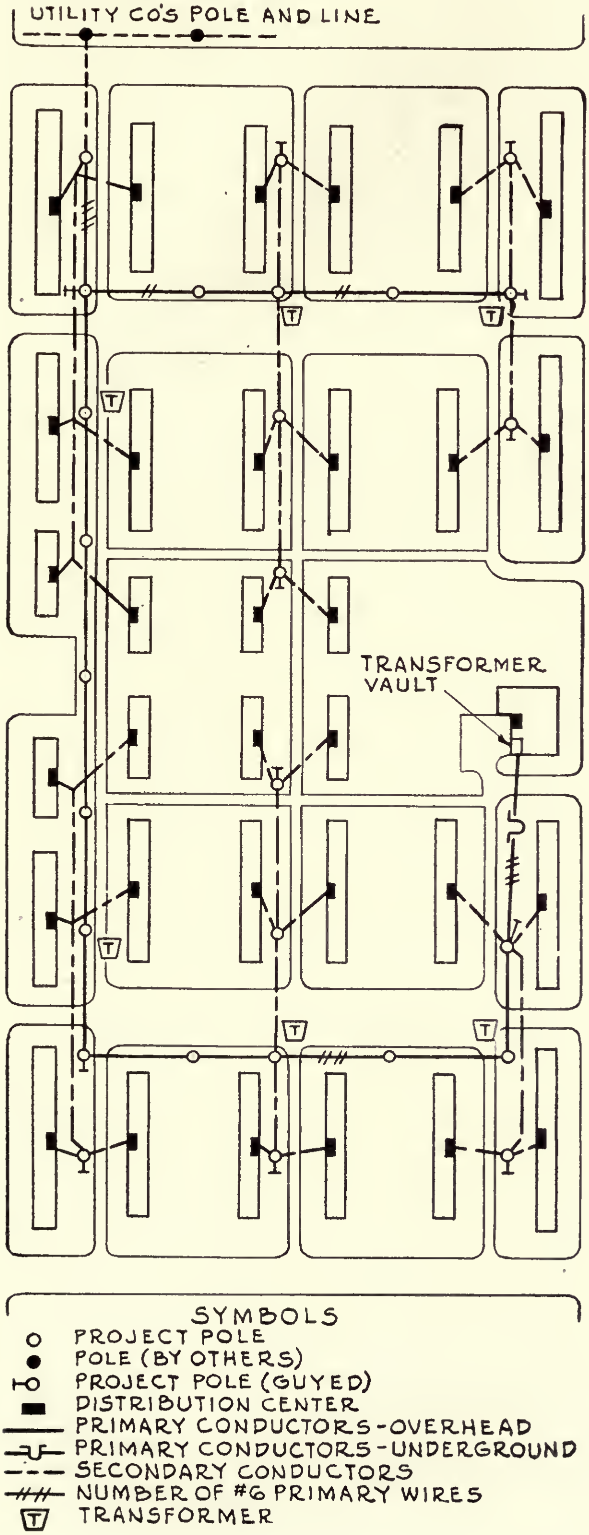


Figure 20. Diagram of pole line distribution

It is desirable to limit pole spans to 125 feet. By placing transformer stations in the center of loads and by limiting the sizes to one 37½ KVA or three

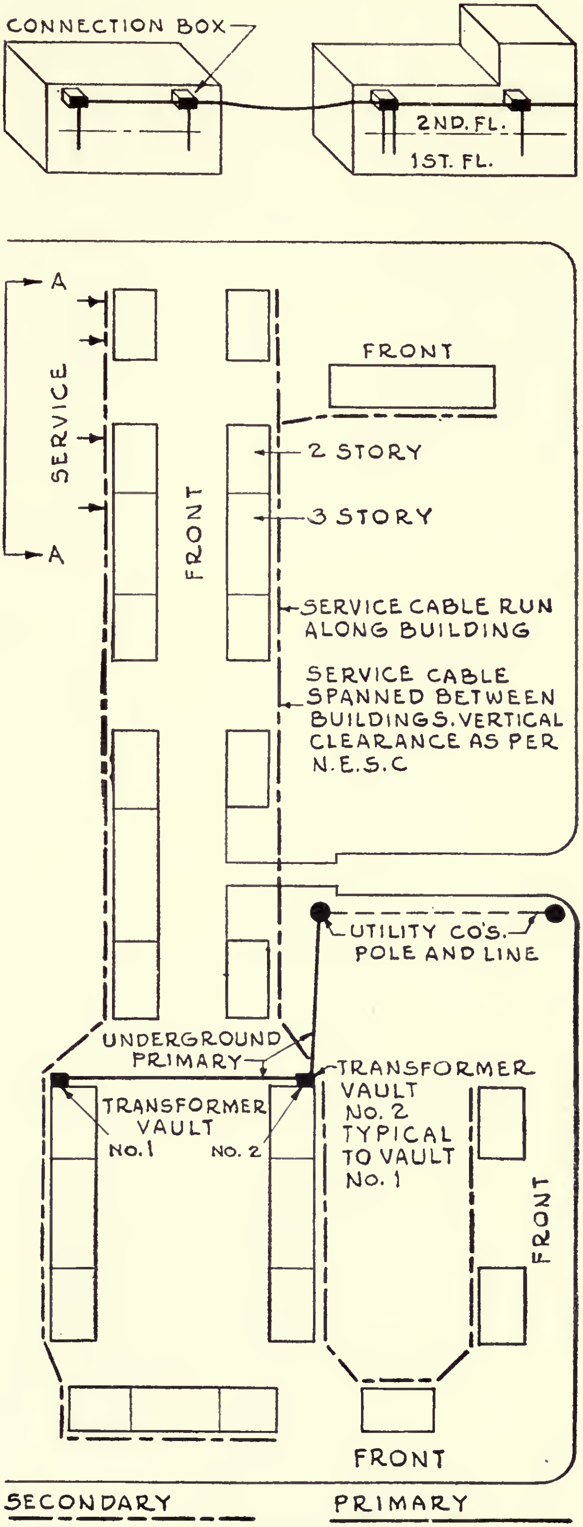

CONNECTION BOX
2ND. FL.
1ST. FL.
A
A
SERVICE
FRONT
FRONT
2 STORY
3 STORY
SERVICE CABLE RUN ALONG BUILDING
SERVICE CABLE SPANNED BETWEEN BUILDINGS. VERTICAL CLEARANCE AS PER N.E.S.C
UTILITY CO'S. POLE AND LINE
UNDERGROUND PRIMARY
TRANSFORMER VAULT No. 2 TYPICAL TO VAULT No. 1
TRANSFORMER VAULT
No. 1
NO. 2
FRONT
FRONT
SECONDARY
PRIMARY

Figure 21. Diagram of distribution with cable supported on buildings

15 KVA per pole, the secondary lines will generally be economical in size, and the length of runs will not be excessive. Secondary runs which exceed 400 feet in length are uneconomical.

The extent of guying required will be kept to a minimum by avoiding needless changes in direction. Guys must be so located as not to obstruct walkways, play areas, parking areas, etc., or to interfere with the trees.

Clearance of service drop conductors over roadways, walks, lots and buildings should conform with the requirements of the National Electrical Code, Section 2322.[1]

Secondary Distribution on Buildings. Where the arrangement and type of buildings and other conditions permit, stringing secondary lines along buildings rather than on pole structures will eliminate overhead pole structures to some degree.

Transformer Stations. Transformation in one step, wherever practicable, will avoid the increased core and copper losses and switching equipment costs.

Studies comparing the cost of completely self-protected transformers, without auxiliary devices, with that of the conventional transformer having externally mounted protective and disconnecting devices are important, since the selection may affect the transformer size. A study of lighting, refrigeration and cooking loads on existing projects indicates that the most serious overload condition is encountered for a one-hour period after the transformers have been operating at full load for an indefinite period. A comparison of sizes of the conventional type of transformer having primary protection, with the completely self-protected type having secondary circuit breaker protection is given in the following table.

TABLE XI

TRANSFORMER SIZES LIGHTING, REFRIGERATION AND COOKING LOADS

No. of DU	*Demand*		*Conventional type*		*Completely self-protected type*	
	KW per DU	*Total*	*Size of 1 ϕ trans.*	*Size of three 1 ϕ trans.*	*Size of 1 ϕ trans.*	*Size of three 1 ϕ trans.*
1	4.00	4.00	3	3 x 1.5	3	3 x 1.5
2	3.65	7.30	5	3 x 1.5	3	3 x 1.5
3	3.30	9.90	7½	3 x 3	5	3 x 1.5
4	3.20	12.80	10	3 x 3	7½	3 x 1.5
5	3.20	16.00	10	3 x 3	7½	3 x 3
6	3.20	19.20	15	3 x 5	10	3 x 3
7	3.00	21.00	15	3 x 5	10	3 x 3
8	2.80	22.40	15	3 x 5	15	3 x 3
9	2.70	24.30	15	3 x 5	15	3 x 5
10	2.60	26.00	25	3 x 7½	15	3 x 5
11	2.50	27.50	25	3 x 7½	15	3 x 5
12	2.45	29.40	25	3 x 7½	25	3 x 5
18	2.15	38.70	25	3 x 10	25	3 x 7½
24	1.85	44.40	37½	3 x 10	25	3 x 7½
30	1.62	48.60	37½	3 x 15	37½	3 x 7½
36	1.55	55.80	37½	3 x 15	37½	3 x 10
42	1.49	62.60	50	3 x 15	37½	3 x 10
48	1.43	68.60	50	3 x 15	37½	3 x 15
54	1.40	75.60	50	3 x 25	50	3 x 15
60	1.40	84.00	75	3 x 25	50	3 x 15

---

[1] National Board of Fire Underwriters. Chicago, 1940.

UNDERGROUND EQUIPMENT

Raceways. It is desirable that routing of raceways be related to finished site contours.

Primary Cable and Connections. Lead-covered cable has proved entirely satisfactory as an underground conductor, except in some coastal areas where chemical action has eaten through the lead sheath within a period of three to five years. Experience gained over the last fifty years, however, indicates that under normal conditions the life of lead-covered cable may be figured conservatively at fifty years.

Non-leaded primary cables have been used for only a relatively short time. Where they are used it is necessary that great care be exercised in the selection of the type and grade.

Secondary Cable. (Voltages up to 600). Non-leaded secondary conductors have been in use for a number of years on a relatively large scale, and experience with this type of cable has been satisfactory. It is easier to handle and to terminate, and is appreciably less expensive than leaded cable.

Parkway Cable. Cable designed for laying directly in the ground (where soils are favorable) will usually cost less initially.

Drainage. Serious damage may result if raceways, vaults and manholes accumulate subsurface and surface water. Raceways must not be trapped. Access covers raised above surrounding grades will allow water to run away from openings. French drains or rock-bed drains are satisfactory only where soil is absorptive.

> A number of projects of the various housing authorities have experienced trouble with the accumulation of water in electric conduits. It is believed that this water or condensate gets into the system when the job is originally built and that the swabbing of the conduit before pulling the wire would eliminate this condition. — Regional Report

Feeder and Transformer Sizing. A diagram is reproduced to show the system and routing of the electrical distribution for a project, as well as sizes of primary and secondary feeders and capacities of the transformer protective devices and disconnects.

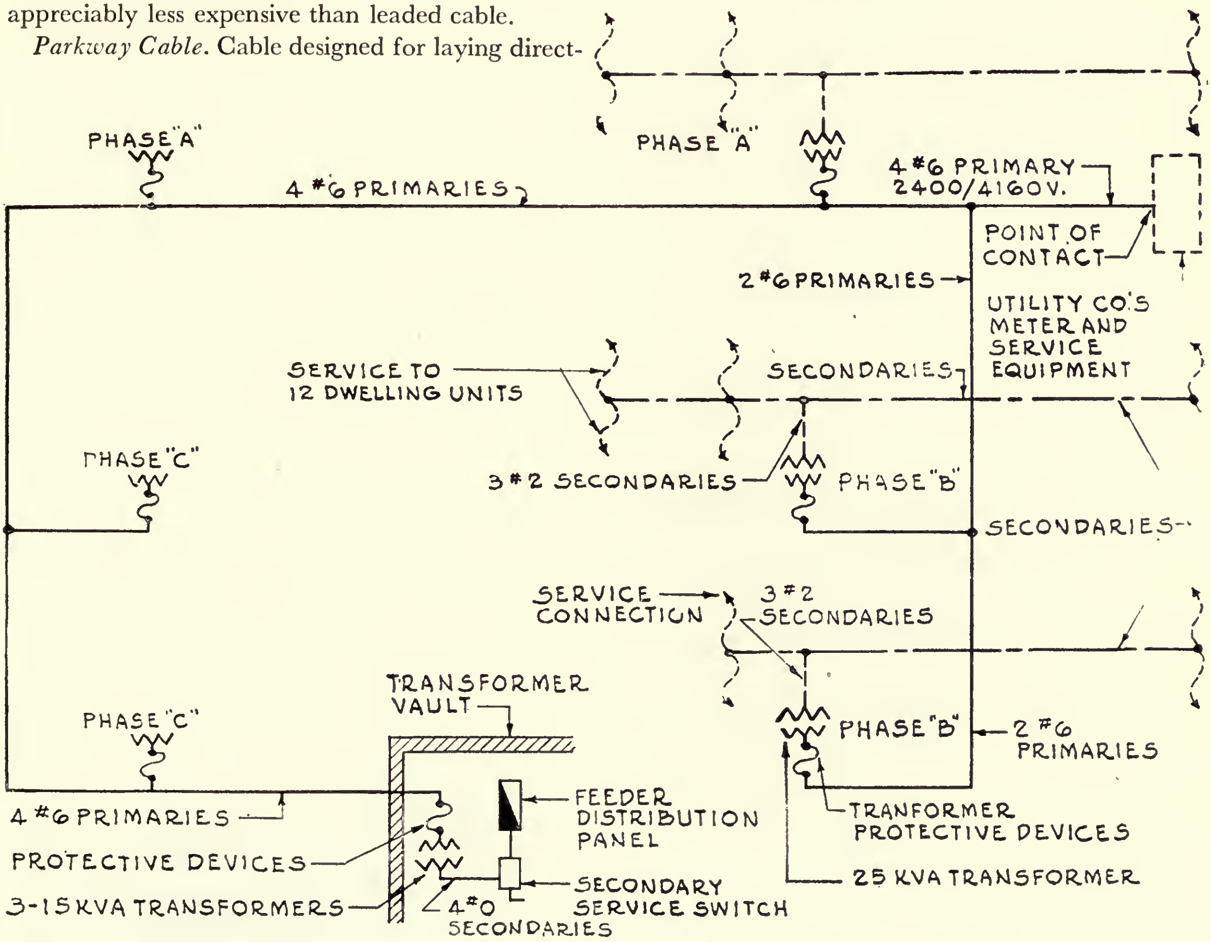
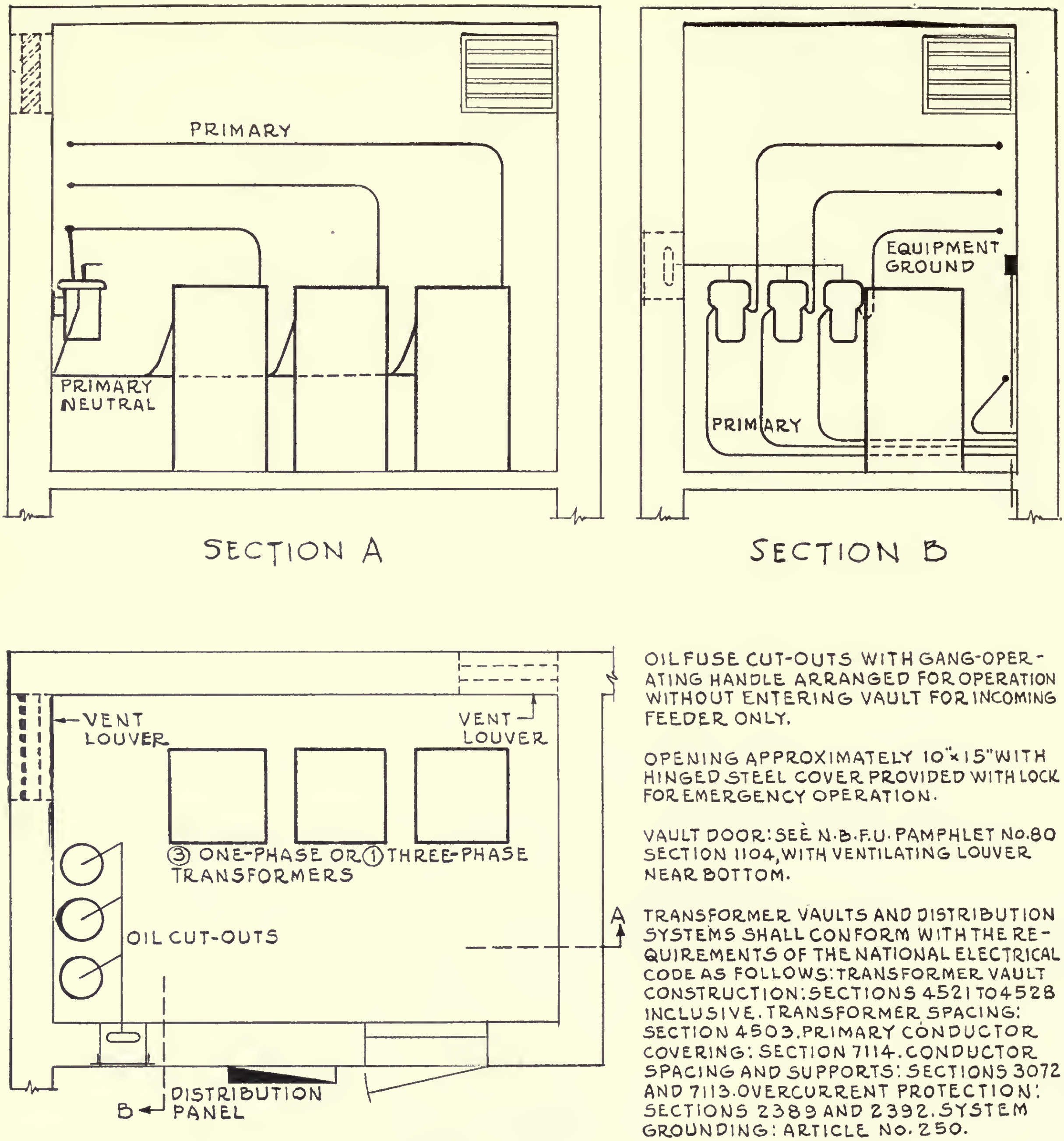


Figure 22. Diagram showing electrical system and routing. Note: Sizes indicated are for example only



OIL FUSE CUT-OUTS WITH GANG-OPERATING HANDLE ARRANGED FOR OPERATION WITHOUT ENTERING VAULT FOR INCOMING FEEDER ONLY.

OPENING APPROXIMATELY 10"×15" WITH HINGED STEEL COVER PROVIDED WITH LOCK FOR EMERGENCY OPERATION.

VAULT DOOR: SEE N.B.F.U. PAMPHLET No. 80 SECTION 1104, WITH VENTILATING LOUVER NEAR BOTTOM.

TRANSFORMER VAULTS AND DISTRIBUTION SYSTEMS SHALL CONFORM WITH THE REQUIREMENTS OF THE NATIONAL ELECTRICAL CODE AS FOLLOWS: TRANSFORMER VAULT CONSTRUCTION: SECTIONS 4521 TO 4528 INCLUSIVE. TRANSFORMER SPACING: SECTION 4503. PRIMARY CONDUCTOR COVERING: SECTION 7114. CONDUCTOR SPACING AND SUPPORTS: SECTIONS 3072 AND 7113. OVERCURRENT PROTECTION: SECTIONS 2389 AND 2392. SYSTEM GROUNDING: ARTICLE No. 250.

Figure 23. Layout for a typical transformer room

Transformer Stations. It is advantageous to prepare cost comparisons for placing transformers in (1) vaults within buildings, (2) underground vaults independent of buildings, and (3) vaults or kiosks above grade. Kiosks may be developed in connection with comfort stations, tool sheds, or telephone booths, and may be landscaped so as to be inconspicuous. Underground vaults independent of buildings require subway-type transformers and equipment costing more than standard distribution equipment. Vaults within buildings or kiosks above grade are most accessible and, therefore, servicing and maintenance are economical.

A typical transformer room layout using three single-phase, standard type transformers is illustrated. The drawing shows the items to be considered in the design of a transformer room, including clearances around equipment, ventilation and fire protection.

Use of three-phase transformer units rather than single-phase units warrants consideration. The advantages are that they occupy less floor space, weigh less, have lower core losses, require handling and connecting of only one unit, and cost less. With transformer sizes the same throughout, a spare unit may be kept on hand for ready replacement in case of breakdown.

"Load center power units" of capacities ranging from 50 KVA to 150 KVA are available for transforming electrical energy. The unit is factory-assembled and shipped from the manufacturer as a complete metal-enclosed "load center unit", consisting of (1) high voltage protection, (2) meter transformer space where required, (3) transformation, and (4) low voltage protection.

Doors and openings to vaults and manholes must be large enough to permit removing or replacing of equipment. Transformer vaults should conform to the requirements of the National Electrical Code, Article 450, and to the requirements of the local utility company. Foreign pipes and ducts should not come within switch-rooms or transformer vaults.

Protective Devices. The use of oil fuse cutouts for short circuits and for overload protection on each phase leads to a simple, rugged, primary disconnecting means; these cutouts are available for gang operation when load break is desired. At a slight increase in cost, the operating lever may be extended so as to be worked from outside the vault. Cutouts other than the oil fuse type equipped with isolating disconnect switches will permit replacing blown fuses without undue operating hazard. These require more equipment and more space, than the oil fuse type.

In underground distribution centers, removable disconnecting links are more desirable than fuse protection.

ILLUMINATION

Design Considerations. Proper site illumination promotes safety and convenience at night. Faces of people passing by should be recognizable at close range.

Objects at night are seen by silhouette, by contrast, and to a lesser extent by their own brightness. It is desirable to place lighting units close to sidewalks and to other light colored backgrounds rather than, for example, in the center of dark grass plots. Location of the units along the walk, where possible, will also throw direct light upon pedestrians.

High intensities of light are not necessary to show contrasts or silhouettes, but it is desirable to have uniform distribution. Since light diminishes very rapidly as the distance from the source is increased, a reflecting medium projecting much of the light away from its source is sometimes used effectively.

Glare causes a decrease in the ability of the eye to see, and should, therefore be eliminated as far as possible. The higher the light source above eye level, the less the glare. When glare is considered as 1 at 32 feet mounting height, for example, it is increased to 8.4 at 12 feet mounting height.

Glare may be controlled by reflectors covering the lamp and distributing the light by controlled reflection, since it is caused by the intrinsic brightness of the unit.

Yard Lighting. The effect of trees on distribution of light should be considered carefully in laying out yard lighting. It is desirable that units be so placed that trees will not cause shadows over large areas. It is in the interest of safety to place a light source at steps and along walks to allow direct illumination from the light units.

Building arrangements and their heights govern the spacing and mounting heights of light sources. The higher the mounting height, the broader the light distribution. The mounting height is related to building height; for example, two-story buildings may permit 18 foot mounting heights, whereas one-story buildings need mounting heights of 12 to 15 feet for pleasing appearance. It is desirable to locate the light source away from near-by dwelling windows.

A sloping site generally requires a larger number of light units than a flat site covering the same area. Unit spacing is important in obtaining uniform distribution of the light. In order to obtain uniformity, spacing between units not to exceed 12 times the mounting height is a fair rule to follow. Where appearance demands low mounting heights, closer spacing is necessary in order to provide uniformity of light.

Unless large quantities of fixtures are required a stock design will be found economical in first cost and in maintenance. Where the local municipalities have adopted certain types of fixtures, the use of such standards should result in lowering maintenance expense.

The posts of lighting standards are available in steel, concrete or wood. Wood posts cost less, but their life is somewhat shorter than that of steel or concrete. Concrete posts, although not so widely used by municipalities for street lighting as steel posts, look well in yards of large housing projects.

Sturdy, non-breakable equipment is preferred since outdoor equipment will be subject to rough use and abuse. It is advisable that the lighting unit be durable and that it protect the lamps.

Play Area Lighting. The amount of illumination should be discussed with the local recreation authorities. Floodlights, if used, are best mounted on plain tubular poles or on adjacent buildings, and are usually connected to project circuits with provision for separate metering. If the floodlights are to be furnished by the local recreation authorities, provision of raceways for future installation of cables, fixtures, etc., may be adequate.

It is desirable that yard lighting be controlled from a single time clock, using pilot wires for operation of the conductors controlling the lighting circuits.

Obstruction Lighting. It may be necessary to illuminate a high chimney or other obstruction in the path of air traffic. The Civil Aeronautics Authority, Washington, D. C., should be consulted for their approval of the proposed layout and equipment.

SIGNALING AND COMMUNICATION

Fire and Police Alarm Systems. City officials should be consulted with regard to municipal fire and police alarm systems. The local municipality should provide and maintain new stations, relocate existing stations and re-route or extend connecting lines.

Telephone Systems. The local telephone company should be consulted in the preparation of plans for telephone facilities in order that their experience may be used to obtain the most economical layout. The service of their engineers is available, usually without cost, for consultation and advice on all matters pertaining to telephone systems for low-rent housing projects. The number of installations in existing low-rent projects varies from 2 to 55 percent of the number of dwelling units.

Site facilities for a telephone system depend, to a large extent, on the means of electrical distribution for lighting and power. If project-owned overhead pole structures are planned, telephone lines usually can be brought from outside the property line to these poles. The voltage of the electrical system, however, may decide whether or not the pole structures can carry communication lines.

Where no overhead distribution exists, underground ducts (or trenches for buried cables) are used.

Public Telephone. Pay telephone stations on the project are essential unless public telephone facilities are available close to the project.

Floodlights are used for games, community gatherings and dramatics

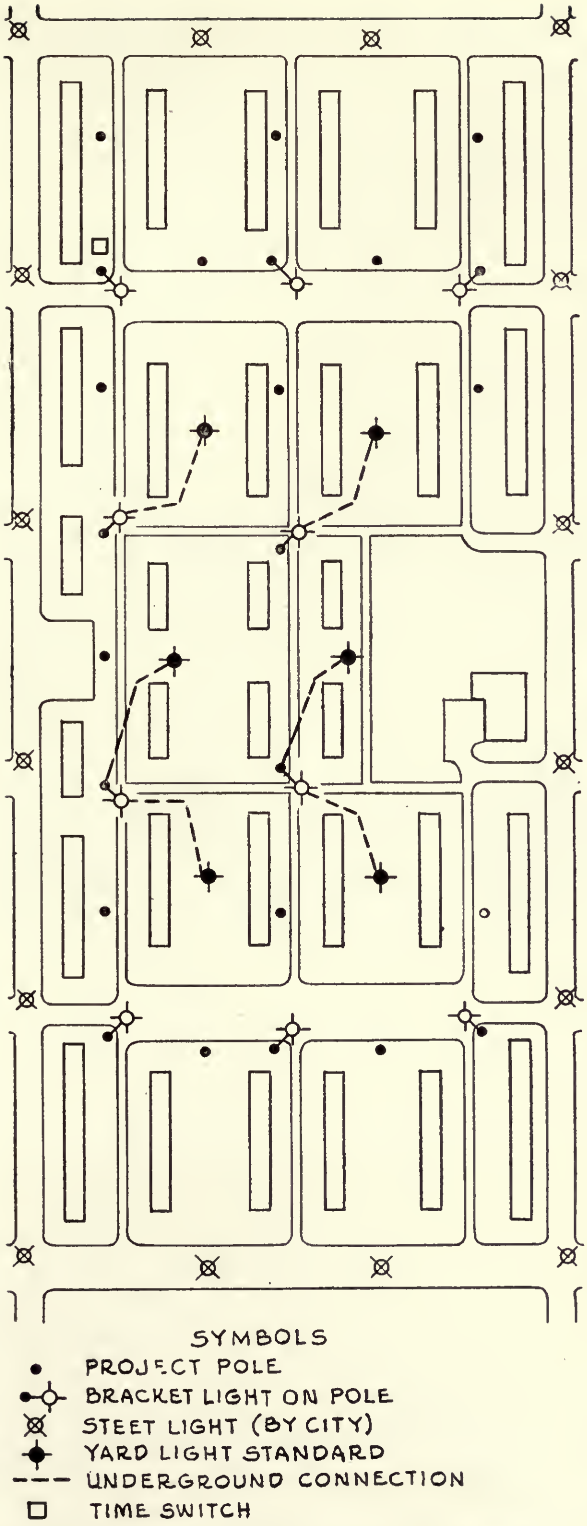


Figure 24. Overhead and underground combination of yard lighting

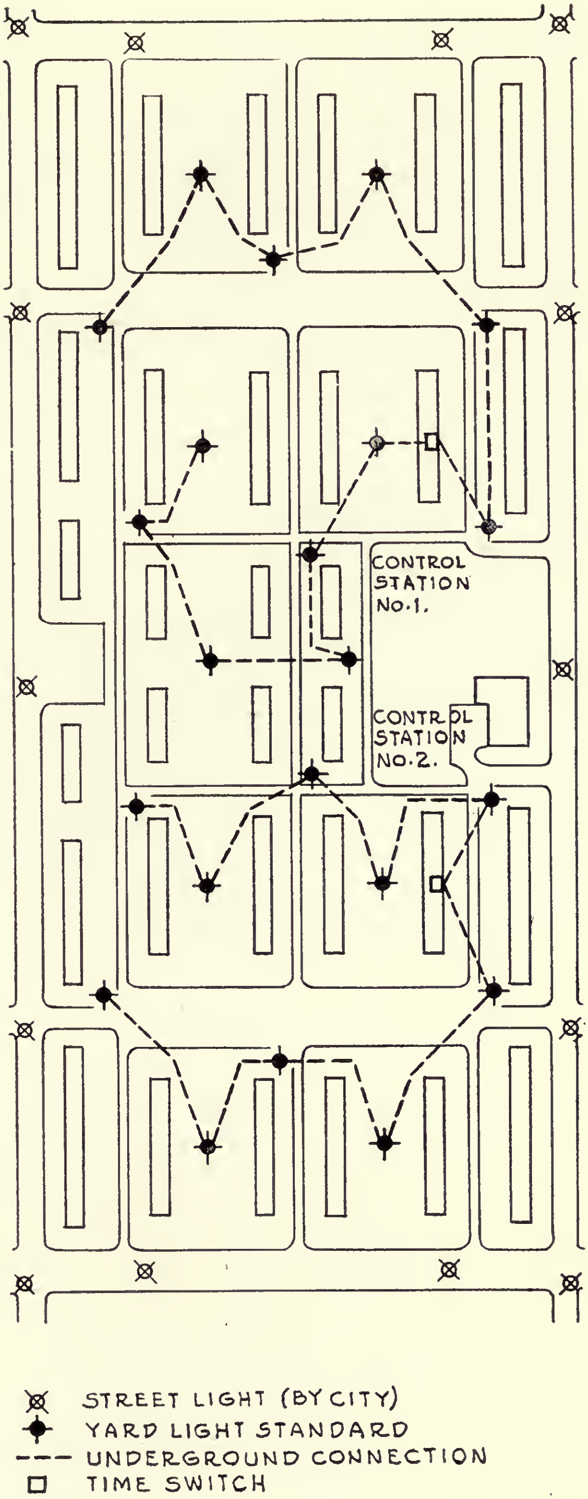


Figure 25. Underground yard lighting system

Families may overload circuits with electric conveniences

INTERIOR WIRING

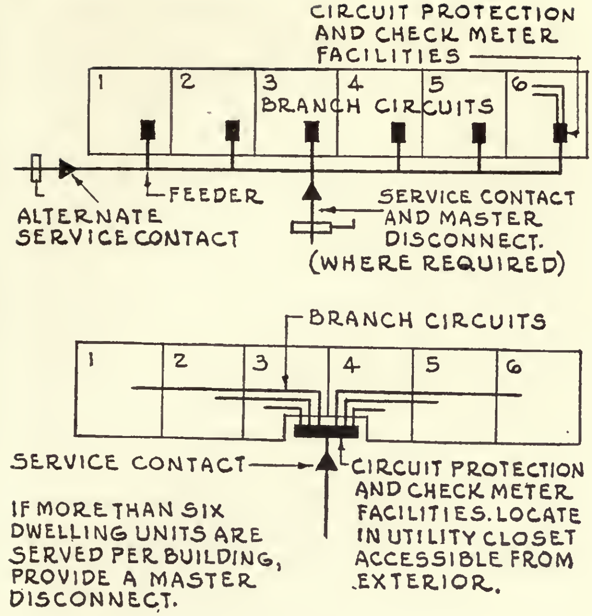
The requirements of a low-rent housing project for indoor light and power differ very little from those of any private development. In public projects, however, it is observed that designers at times have disregarded the probability that added electrical equipment might be used in the future.

Reports and studies made by regional office and local housing authorities stress the desirability of more circuits (or wires large enough to carry the load without uneconomical voltage drop) than have been provided in the past. They note also a need for better protection of circuits as well as for sufficient and conveniently placed outlets.

> Electricity: This seems satisfactory, both as to number and placing of outlets. The fixtures are simple and good. — Pennsylvania
>
> Electric Outlets: More of them desired, especially in the living room. — California
>
> Electric Outlets: Not enough in living room. — New York
>
> Baseboard outlets useless behind ice boxes. Those by front door too far from lamps. — Washington State
>
> Additional electric convenience outlets should be provided in the kitchens and living rooms. — Connecticut

Installation Details. Experience in low-rent work underlines the following items:

1. It is hazardous, in frame buildings, to install service entrance conductors more than five feet long in hollow spaces, unless they are provided with overload protection.
2. The most satisfactory location for service-disconnect equipment is within the building to be served, near or connected to the branch circuit


CIRCUIT PROTECTION AND CHECK METER FACILITIES
1
2
3
4
5
6
BRANCH CIRCUITS
FEEDER
ALTERNATE SERVICE CONTACT
SERVICE CONTACT AND MASTER DISCONNECT. (WHERE REQUIRED)
BRANCH CIRCUITS
1
2
3
4
5
6
SERVICE CONTACT
CIRCUIT PROTECTION AND CHECK METER FACILITIES. LOCATE IN UTILITY CLOSET ACCESSIBLE FROM EXTERIOR.

IF MORE THAN SIX DWELLING UNITS ARE SERVED PER BUILDING, PROVIDE A MASTER DISCONNECT.

Figure 26. Feeder distribution for row houses. Individual (above); group (below)

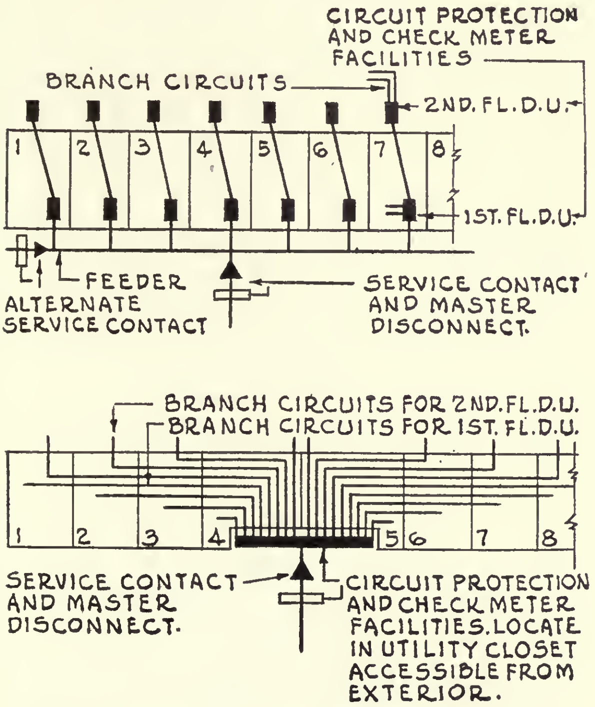
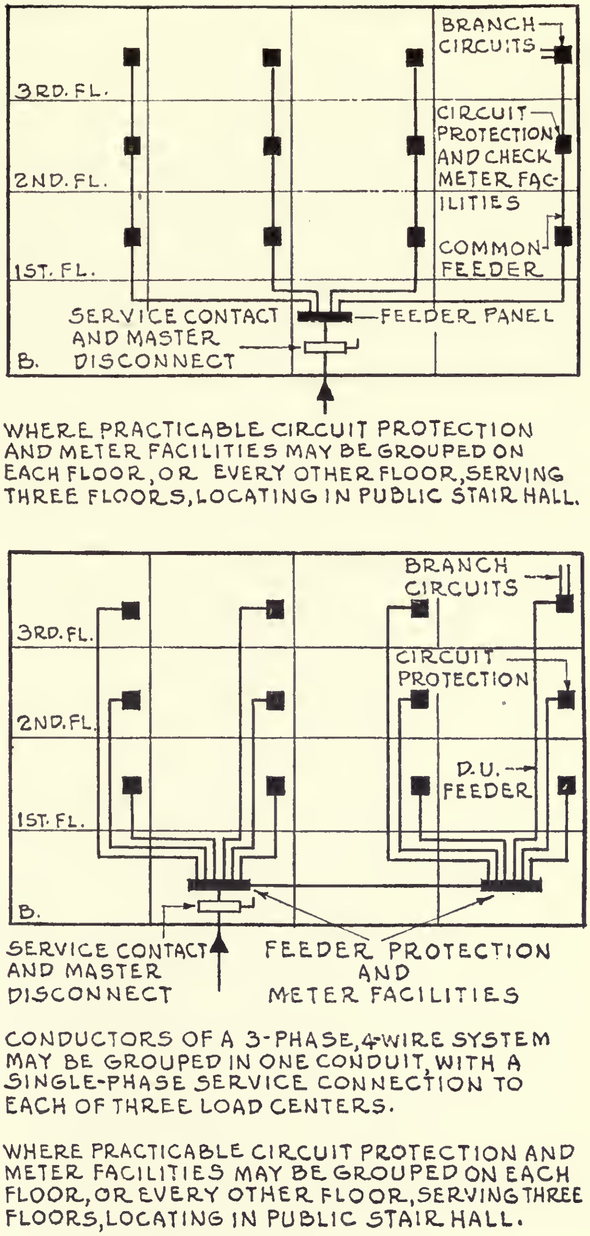

CIRCUIT PROTECTION AND CHECK METER FACILITIES
BRANCH CIRCUITS
2ND. FL. D.U.
1
2
3
4
5
6
7
8
1ST. FL. D.U.
FEEDER
ALTERNATE SERVICE CONTACT
SERVICE CONTACT AND MASTER DISCONNECT.
BRANCH CIRCUITS FOR 2ND. FL. D.U.
BRANCH CIRCUITS FOR 1ST. FL. D.U.
1
2
3
4
5
6
7
8
SERVICE CONTACT AND MASTER DISCONNECT.
CIRCUIT PROTECTION AND CHECK METER FACILITIES. LOCATE IN UTILITY CLOSET ACCESSIBLE FROM EXTERIOR.

Figure 27. Feeder distribution for flats Individual (above); group (below)

or feeder distribution center. The disconnect handle should be about five or six feet above the floor so that it cannot be reached by children.


BRANCH CIRCUITS
3RD. FL.
CIRCUIT PROTECTION AND CHECK METER FACILITIES
2ND. FL.
COMMON FEEDER
1ST. FL.
SERVICE CONTACT AND MASTER DISCONNECT
FEEDER PANEL
B.
BRANCH CIRCUITS
3RD. FL.
CIRCUIT PROTECTION
2ND. FL.
D.U. FEEDER
1ST. FL.
B.
SERVICE CONTACT AND MASTER DISCONNECT
FEEDER PROTECTION AND METER FACILITIES

WHERE PRACTICABLE CIRCUIT PROTECTION AND METER FACILITIES MAY BE GROUPED ON EACH FLOOR, OR EVERY OTHER FLOOR, SERVING THREE FLOORS, LOCATING IN PUBLIC STAIR HALL.

CONDUCTORS OF A 3-PHASE, 4-WIRE SYSTEM MAY BE GROUPED IN ONE CONDUIT, WITH A SINGLE-PHASE SERVICE CONNECTION TO EACH OF THREE LOAD CENTERS.

WHERE PRACTICABLE CIRCUIT PROTECTION AND METER FACILITIES MAY BE GROUPED ON EACH FLOOR, OR EVERY OTHER FLOOR, SERVING THREE FLOORS, LOCATING IN PUBLIC STAIR HALL.

Figure 28. Feeder distribution for apartments Individual (above); group (below)

3. Branch circuit protection may be located within a dwelling unit, fed from a common feeder or from feeders emanating from a distribution panel. This protection may be grouped at the point of service contact; such an arrangement will not permit the installation of check meters within the dwelling unit. See illustrations of feeder arrangements for row houses, flats and apartment buildings.

4. If meters are installed in crawl spaces or basements, there should be at least 6′-6″ clear headroom at the meter location and throughout the passage giving access to meters.

> The placing of circuit breakers and electric boxes in the crawl spaces is very bad. When an overload occurs, the power goes off in a house and a maintenance man must be found to reset the circuit breaker. After 4:30 P.M. only one man is on the project and very often a tenant is without electricity for hours. The electric boxes in the crawl spaces are rusting badly and the service men have to wade around in water and mud to get to them. — New York

5. Meter loop provision in the wiring system for future installation of individual tenant meters is recommended. If energy used for non-dwelling project service is centralized, as in the case of project heating plants, and if it is difficult for management to estimate energy consumption, provision for metering facilities is necessary.
6. Individual tenant meters should be installed only after operating experience on the project has indicated the necessity for them. When meters are needed, a one hundred percent installation is usually made. Where adequate energy and fuel for all utility functions—lighting, refrigeration, cooking, domestic hot water and space heating—are furnished by the project and included in the tenants' leases, meters have not been found necessary or desirable. Check meters are useful, however, when fuel or energy for some utilities are project-furnished and for others are tenant-furnished; in such a case they guard against the misuse of project energy.

> Gas and electricity should either be 100 percent metered or not at all — preferably 100 percent metered. — Massachusetts

It is more convenient for tenant reading to have the meters placed either within the dwellings or immediately outside than to have them all grouped in one place in the building.

A weatherproof meter cabinet

The advantages and disadvantages of placing meters inside and outside of dwelling units may be outlined as follows:

Inside. Advantages: (1) The meter is in view of tenant. (2) Non-weatherproof equipment may be used. (3) Simplified wiring and direct mounting on a protective cabinet results in lower initial cost. (4) Management collection of excess charge is made easy when the meter is read in the tenants' presence, since disagreements are thus avoided.

Disadvantages: (1) Requires management time to visit each dwelling unit periodically, say four or five times annually. All meters should be read on a given day, and there may be difficulty in gaining entrance on the day set for meter reading. (2) The meter readers may be required to listen to tenant complaints which should be handled by the management office. This delays the completion of meter readings.

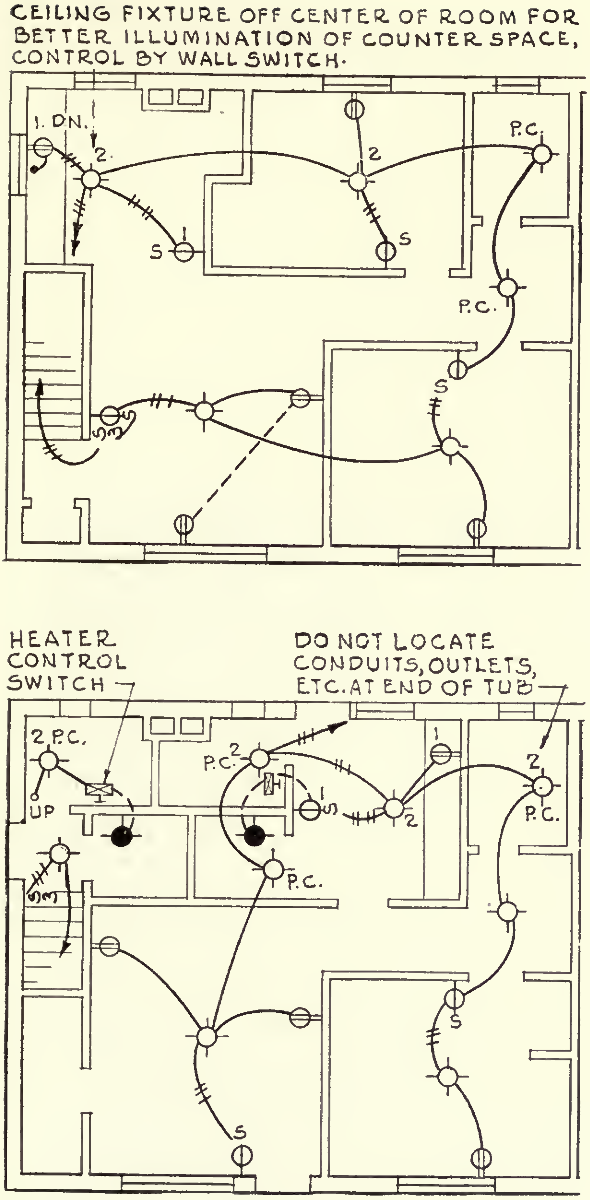
Outside. Advantages: (1) Equally accessible to management and tenant, eliminating the need for return calls.

Disadvantages: (1) Not prominently in view of tenants, particularly in flats and apartment buildings where it is difficult to find a satisfactory location. (2) Weatherproof equipment is needed in certain types of buildings, such as row houses and flats. (3) Greater initial cost, because of added wiring and weatherproof equipment, where needed.

> Do not locate circuit protective devices outdoors where they are exposed to weather, or in crawl spaces. If located below the first floor of a building with crawl space, provide a room with access from the outside with full headroom and positive drainage to insure a dry room. — Regional Report

The most satisfactory division of circuits appears to be:

1. General purpose (15 amp.) circuits serve: fixed lighting outlets throughout the unit, and those not served by other circuits.
2. Appliance circuits (20 amp.) serve: outlets (other than lighting) in kitchen, dining space and utility room.
3. Individual circuits serve: single appliances or equipment units, such as the cooking range or water heater. If such equipment is not required by the initial design, it is still advisable to include the circuit for possible future use.

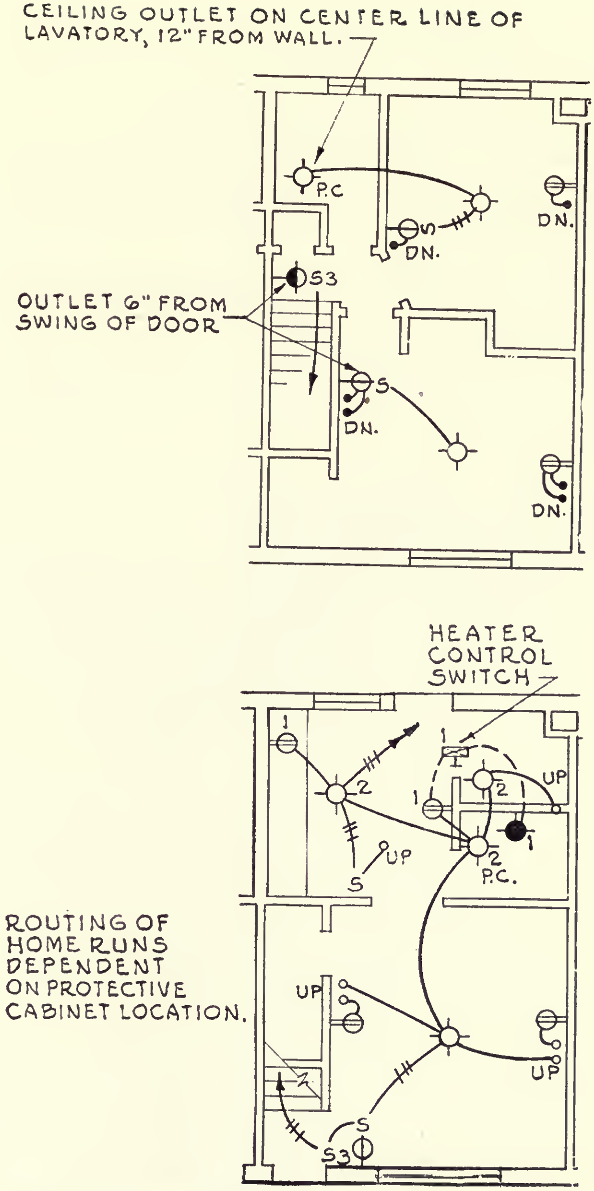


CEILING FIXTURE OFF CENTER OF ROOM FOR BETTER ILLUMINATION OF COUNTER SPACE, CONTROL BY WALL SWITCH.

HEATER CONTROL SWITCH

DO NOT LOCATE CONDUITS, OUTLETS, ETC. AT END OF TUB

Figure 29. Wiring plan for two-story flats
First floor (below); second floor (above)



CEILING OUTLET ON CENTER LINE OF LAVATORY, 12" FROM WALL.

OUTLET 6" FROM SWING OF DOOR

HEATER CONTROL SWITCH

ROUTING OF HOME RUNS DEPENDENT ON PROTECTIVE CABINET LOCATION.

Figure 30. Wiring plan for two-story row house
First floor (below); second floor (above)

Lighting Fixtures. Fixtures in public housing should be interchangeable and readily replaced. They should be low in first cost, simple in design and durable. Some projects are so equipped that replacement of the socket and sometimes of the switch can be made without canopy or fixture replacement.

Since some tenants have no portable lighting fixtures it is important that every room in the dwelling be equipped with a fixture.

Artificial illumination in the dwellings is usually four to six foot-candles, measured in a horizontal plane 30 inches above the floor area in each occupied room. Fifteen foot-candles are normally allowed for reading or sewing. On stairs and in passageways, one foot-candle power is desirable.

The type of lighting fixtures which have been found most satisfactory are listed below:

Living Rooms. Semi-indirect ceiling fixtures with 12-inch translucent or opaque bowls fastened to the lamp receptacle holder by chains. Opaque bowls to have louvered openings to give sufficient intensity directly below the fixture for close work. Lamp size: 100 watt. Control: wall switch.

Bedrooms. The same as for living rooms except that the diameter of bowls is approximately 9-inch and without louvers. Lamp size: 60 watt. Control: wall switch.

Kitchens. Ceiling lamp receptacle with approximately 8-inch opal glass globe. Lamp size: 100 watt. Control: wall switch.

Halls and Bathrooms. Ceiling beam fixture with flared ring opening. Lamp size: 25 watt. Control: pull cords.

Utility Rooms. Ceiling lamp receptacle. Lamp size: 25 watt. Control: pull cords.

> Electric Appliances: The use of cheap electrical appliances should be avoided. They require much attention and constant overhauling by the maintenance force to repair shorts, faulty switches and burnt-out elements. The purchase of a more substantial appliance would actually result in a saving of money over a period of time. — Regional Report
>
> Basement ceiling lights should not be obstructed by piping. — Regional Report

A pull switch on ceiling fixtures has been found satisfactory in spaces of small area such as bathrooms, halls, utility closets, and so on, but may involve high maintenance cost unless the pull switches are of good quality. Snubbers or stops at the hole in canopy where the pull chain emerges are provided to relieve strain caused by excessive pulls.

> All lighting fixtures should be controlled by toggle switches instead of pull chains. — Regional Report
>
> We do not recommend any pull chain sockets. — Illinois
>
> Use wall switches in lieu of pull chains for ceiling fixtures. This will increase initial cost but will soon pay for itself by reduced maintenance costs. — Regional Report

Public Vestibules, Halls and Stairways. These are adequately lighted by an intensity of one-third watt to the square foot of floor space, if the light is so distributed that there are no dark areas. Control of this lighting by time switches (supplemented by relays, if necessary) is convenient for the management. Lamp theft from public spaces has been prevented by lock-type sockets or guards, or by left-hand threaded lamp holders.

Community Buildings, Management Office and Shop. Lighting circuits and control switches should be so located that lights not required at all times may be turned off. Pull switches or pull cords generally are less costly in initial installation, but for public places maintenance and replacement is more than that of wall switches.

Particular attention should be given to the lighting of management offices and maintenance shops. Where machine or bench work is necessary, auxiliary lights should be placed so that they will not interfere with the work but will provide proper illumination at work level.

Fixtures in community spaces that are used as playrooms often are equipped with wire guards to save replacement and maintenance.

Details. A mechanical call system mounted directly on the dwelling unit entrance door is cheaper in first cost and in upkeep than an electric system.

Automatic door openers, with their attendant intercommunicating telephones and speaking tubes, are considered unnecessarily expensive for low-rent housing.

One constant complaint on projects where crawl spaces are provided is the lack of convenience outlets near crawl space entrances to which maintenance men can attach a portable 100-foot cord extension.

Telephone Installation. The desirability of providing for future telephone installations in the individual dwelling units is generally recognized. This provision consists of roughing-in to permit the introduction of cables, cable terminals, protectors, and wires at a later date.

Radio Systems. Indoor antennae are adequate for buildings free from reinforced concrete slabs and from metal lath partitions. Ground connections may be obtained from radiators, or from a cold water pipe within the apartment. Under these conditions special provisions for radio reception may be omitted.

In row houses and flats having reinforced concrete slabs and metal lath partitions, sleeves or raceways provided between the dwelling and roof or attic will provide for future antennae installations.

In apartment buildings of fireproof construction, a raceway system for the future installation of a master antenna system has been found desirable.

Lawns and Planting

FIRST considerations in the design of low-rent housing are the development of land for maximum use and enjoyment and for minimum maintenance cost. Since these two objectives often are somewhat incompatible as applied to planting, a carefully studied compromise may be necessary.

Maximum enjoyment, for example, might point to the desirability of heavy tree planting in a certain area, whereas minimum expense of upkeep suggests sparse tree planting to encourage the growth of grass and to facilitate power mowing. Likewise, maximum enjoyment might indicate the provision of a hedge enclosing a certain area, whereas minimum cost of maintenance indicates its omission. In such instances the treatment is determined by the cost of maintenance in relation to the benefits derived by the tenants.

> It is not practical to have small size "postage stamp" lawn areas because of maintenance difficulties. Small areas are much better with solid planting of low growing shrubs. — New York

Intensive use of open areas implies heavy wear and tear. If plants bordering such areas are to survive, they must be tough plants, arranged and protected according to a tough-minded plan. The higher the density of the project the more tough-minded the plan must be. In successful layouts the number of children and adults that can be expected to use each area should be kept constantly in mind. Simplicity of design and suitability of plant materials are essential factors. Plants should be selected for their ability to thrive under unfavorable conditions.

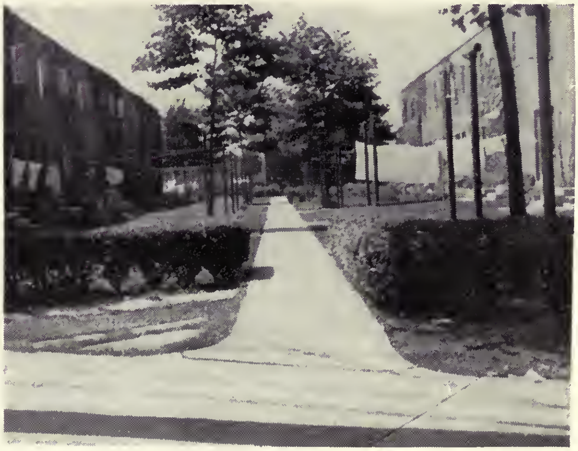
Unless each item in the initial cost of landscape work is kept within a predetermined allowance, one item must give way in favor of another. The landscape architect, like the architect and the engineer, must find ways to make every penny count. In landscape work the preparation of soil and the drainage system are essential for successful planting and low maintenance costs; so if any part of the landscape program must be curtailed in order to keep within the budget, the number and size of the plants should be the first items to be reduced.

Cost is usually related to the dwelling unit rather than to the acre. The density of the project must, of course, be taken into consideration in judging the cost. For example: $75 a dwelling unit for landscape work has been considered a reasonably low figure for a project of 10 families an acre. This amount applied to a project of 50 families an acre would be extremely high. The per-acre cost of landscape work might, however, be the same in each case.

PLANTING DESIGN

Experience in the past ten years has taught many valuable lessons in regard to planting design. The technique normally used in the treatment of private estates and large institutions does not apply to housing projects. The layouts of the grounds of a few of the early public housing projects have had to be adjusted to meet conditions of actual usage; much of this was necessitated by childrens' play. The

Hedge relocated—paved short-cut provided



Appropriate planting defines land use

landscape architect should take advantage of experience by a careful study of conditions at existing projects. Here he can see how the people live, work and play. Such a study will help him to design the grounds for actual rather than for theoretical use.

When planting is appropriate to all special situations it helps to define land use. In low-rent housing everything must work—there is neither space nor money to spare. Almost every part of the project grounds is planned for people doing things: walking to work, to the store, to school or to the playground, hanging out clothes, sunning the baby, roller skating, sitting in the sun or shade, playing games or gardening. Planting can add much to the enjoyment of all these activities and can help to define the intended use of each area, but plants that are not vigorous and not adequately protected will not survive the inevitable hard wear.

Planting is also used to indicate the limits of tenant responsibility and to differentiate between tenant- and project-maintained areas. A hedge, for

The grounds are planned for the use and enjoyment of the people who live in the project

A tall-growing shrub planted so as not to obstruct light and air from windows

example, may mark the transition from project to tenant area—a large shrub or a small tree, near the building wall, may mark the line between tenant yards. Often shade trees are planted on the lot lines to serve as markers. Even in projects of apartments, where maintenance is largely the responsibility of management, some areas may be designed for planting and care by the tenants either individually or in groups.

Planting should be studied in elevation as well as in plan. The ultimate height and spread of each plant should be considered. Tall-growing shrubs should not be planted under windows nor spreading shrubs too near walks or other paved areas. These rules are among the ABC's in the landscape architect's primer, yet violations of them have been noted repeatedly on public housing projects. To avoid constant trimming there should be ample width for the spread of a hedge, shrubs or low-branching trees near walks or streets.

> At basement windows of laundry, perambulator rooms, craft rooms, and other areas which require ventilation, shrubs should be spaced four feet from the building to prevent shutting out light and air. For dead storage areas or other unused basements, shrubs can be planted continuously. — New York

The most successful planting is conceived in broad strokes, in scale with the buildings and the size of the development. In planting the front courts between two parallel buildings, the use of two or, at the most, three varieties of shrubs is more effective and easier to maintain than the same number of plants of a dozen or more varieties. Similarly a bank one hundred feet long planted solidly with, for example, Rosa Wichuriana, is more practical and harmonious than the same area planted in groups of various vines and shrubs. The use of too many types, sizes or species of plants has resulted in spotty effects.

IMPORTANCE OF ADEQUATE PROTECTION

Planting must be protected if it is to survive. More than one-third of the people living in low-rent projects are children, few of whom have been accustomed to lawns, shrubs and trees. Potential damage to plants is particularly great in high-density projects and to planted strips bordering intensively used play areas in all projects.

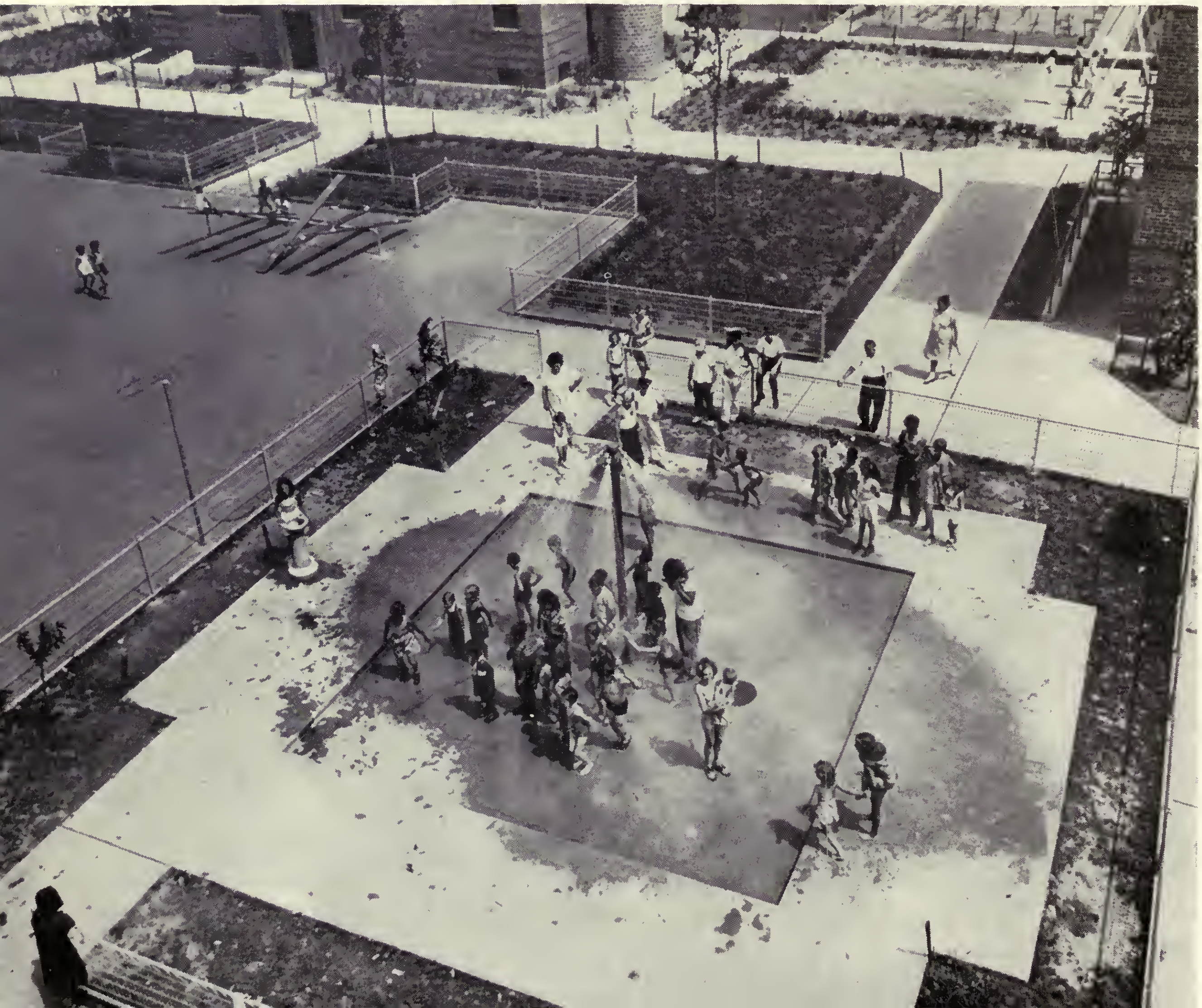
The physical development of the project, indoors and out, must be so well planned that it will stimulate and guide the formation of new habits.

For these reasons, plant protection should be given careful consideration. Protection may be provided by permanent construction (such as by a fence or the wall of a building), by temporary fencing until the plants are large and robust, or by the plants themselves. Where it is impossible to provide adequate protection and the plants are in an exposed location, only thorny or spiny plants, which are self-protecting, should be used. The fact that trailing roses, barberry and certain ground cover plants have needle-sharp thorns, has been the salvation of many steep slopes. Experience with raised planting beds has been good, although there are not many examples of this technique in low-rent housing.

Although large proportion of project is paved, good condition of plants gives opposite effect. — New Jersey

It is good practice to use mass planting at strategic points. — New York

Planting along intensively used play areas requires special protection



Raised planting beds have been used occasionally

Planting at entrances is particularly vulnerable to damage since children invariably play, jump and climb around the entrance platforms. Here cooperation between the architect and the landscape architect will help insure that the entrance planting does not become an eyesore. Ample paved area is essential.

Evergreen trees close to building entrances invariably die. — Regional Report

Ample paved area at dwelling entrances helps to protect adjacent planting

Young children are attracted to young trees

The impulse of children to climb trees, even when "jungle gyms" and other contrivances are provided as an outlet for this healthful energy, must not be overlooked. Neither can their proclivity to peel the bark and otherwise injure trees be ignored. Children seem particularly attracted to young trees, which are, naturally, very vulnerable. Trees in or near intensely used spaces, such as play or sitting areas,

Tree pits in paved areas are used for digging

or in courts between buildings, should be protected by substantial tree guards. Tree pits in paved areas will be used by the children for digging unless they are surfaced with paving blocks or protected by grilles.

The common practice of placing a group of shrubs at the corners of walk intersections on the theory that this will stop corner cutting has been found completely useless. Unless protected by a strong low fence, even barberry bushes have been destroyed in such a position. Hedges bordering walks are also subject to severe damage and should be protected by stout posts and strong wires, at least until they are thoroughly established. Hedges do not in themselves act as barriers or confine the activities of children to a given area. When used for this purpose they should be reinforced by a permanent fence or wall.

> Large, irregularly outlined, mixed shrubbery beds are not appropriate because of excessive cost and maintenance. It is better to have rectangularly outlined beds with shrubs in rows or similar arrangements. — New York

> Avoid using grass in areas between street curbs and sidewalks. — Regional Report

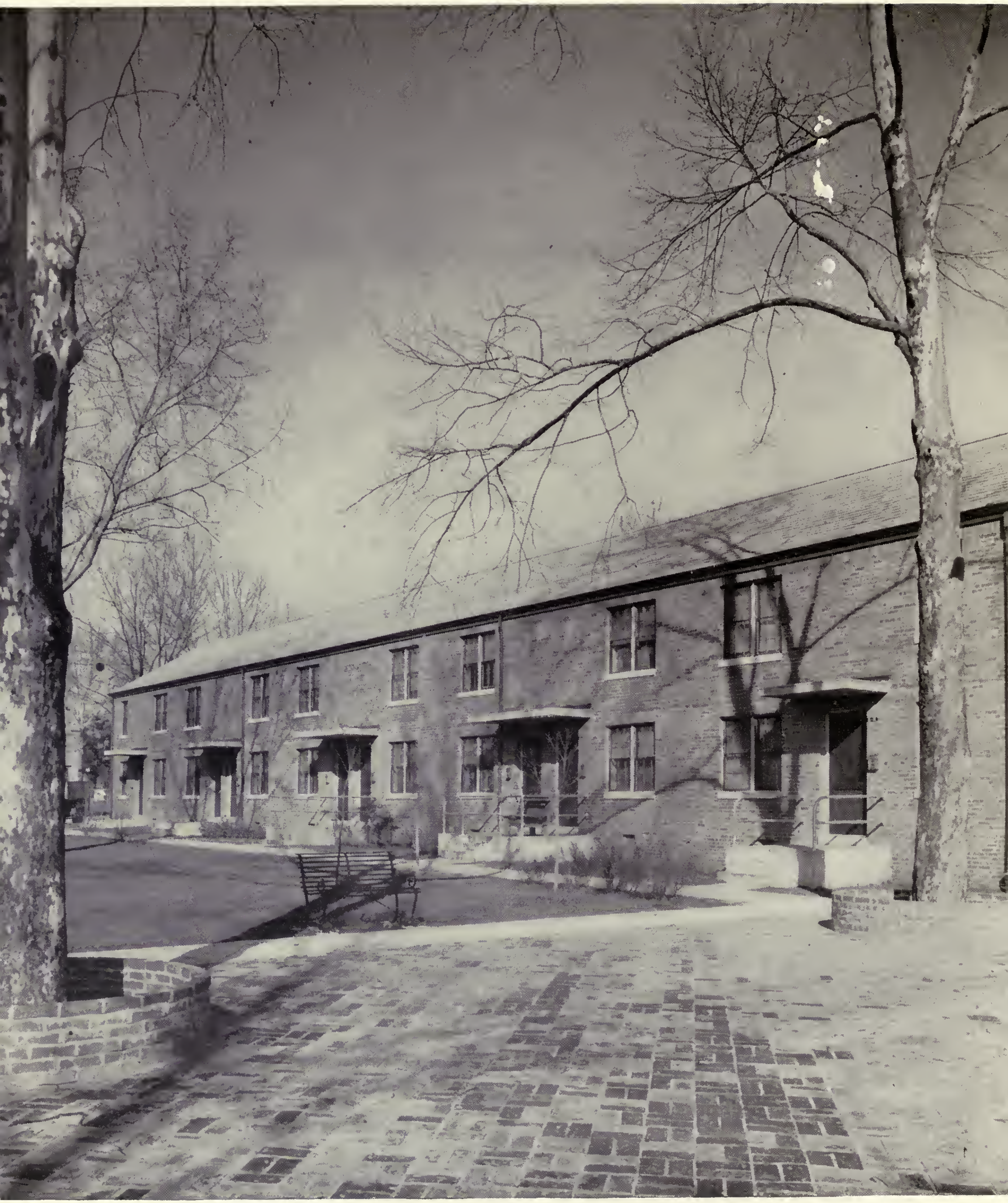
> On the project landscaping we would recommend centralization of shrubs and flower planting rather than planting disposed pell-mell in the front and rear of each dwelling unit. — Rhode Island

ECONOMY OF MAINTENANCE

Careful study should be given to methods of keeping down the maintenance cost of lawns and planting. This is accomplished by planning for as much tenant care as possible, and by planning those spaces which must be project-maintained in such a way that they require little care. To accomplish the first purpose, most outdoor spaces should be related as far as possible to tenant use (with the provision of some kind of boundaries to define individual responsibility). The second purpose can be fulfilled by planning project-maintained areas so that lawns can be cut with power mowers, making them large and regularly shaped, and keeping them free from spotty planting; by planting to control erosion; by avoiding over-planting; by choosing vigorous plants, particularly vines; and, finally, by providing good soil preparation, fertilization and drainage.

Hedges require protection until well established.

Vines require very little care



Large trees create an atmosphere of permanence

EXISTING TREES

Nothing gives such a pleasant atmosphere to a housing project as a few large trees or a group of small ones. Even trees that may survive only a few years are worth saving, as they will provide some shade until newly planted trees develop. Local prejudice against trees such as native pines, ailanthus or locust should not be allowed to influence the landscape architect. It should be remembered that it may be five years before planted trees are effective.

The techniques of preservation are as follows:

1. Examine the trees on the site at the earliest moment and note those to be saved. Have them recorded on the topographic survey, incorporate them in the plan, and if necessary make adjustments in the plan to save them. Since trees are not always accurately located on surveys, a subsequent inspection should be made after the buildings have been staked out. Often a change of a few feet in the position of a building or walk, in no way detrimental to the site plan, will save a valuable shade tree.
2. Prevent damage to existing trees during construction operations. Experience shows that specific detailed requirements for protection must be given. Such phrases as "the contractor shall protect adequately all existing trees which are to remain" have been found useless, unless some one in authority enforces them. Soft-spoken efforts

Locust and other common varieties of native trees can be used effectively

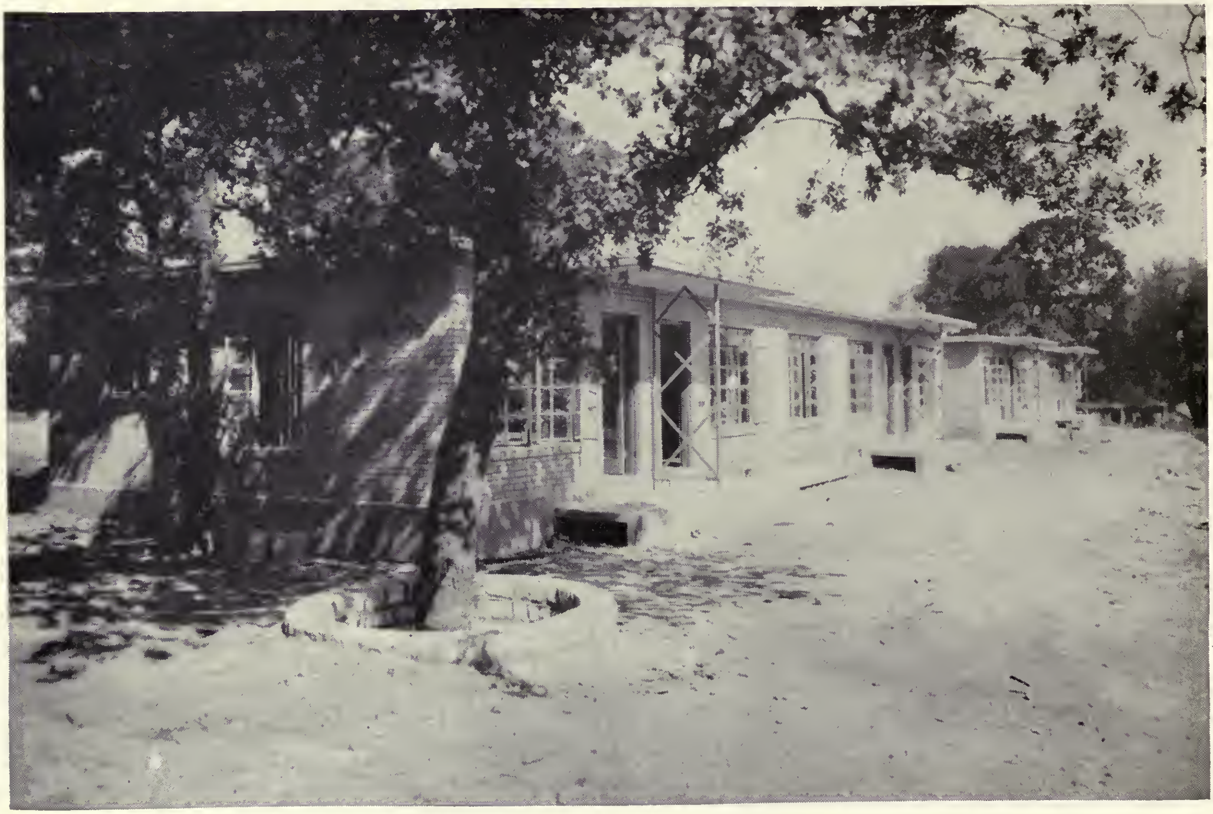
Prevent damage to trees during construction

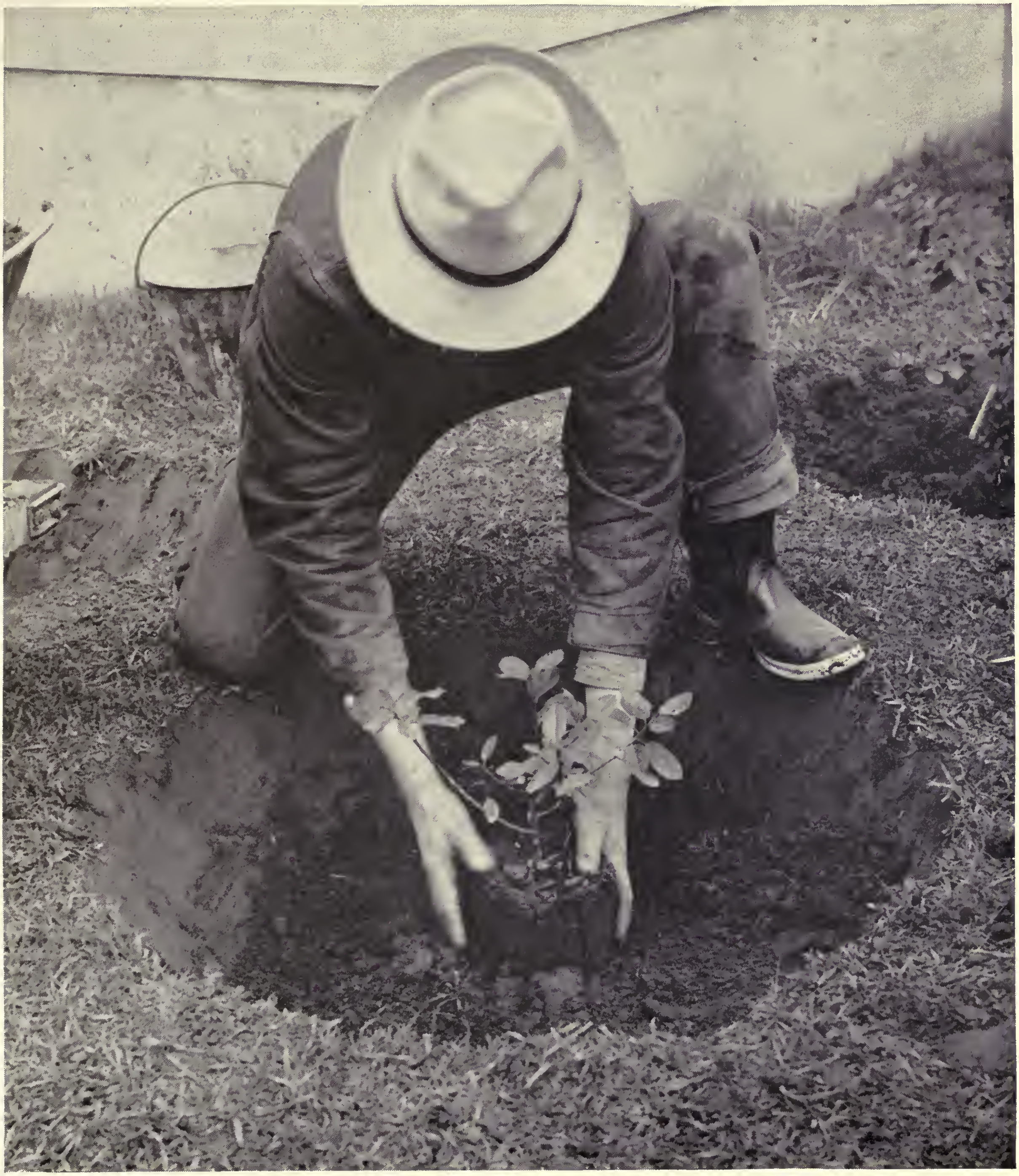
have failed to save hundreds of worth-while existing trees on housing project sites.

Changes in grade sometimes make the preservation of certain trees difficult. When it is feasible, however, and the character of the tree warrants the expense, tree wells, retaining walls or other approved treatment should be provided. The landscape architect must decide whether or not this extra work is justified. In some instances, where the landscape architect was not consulted, relatively large sums were spent on wells around trees which, because of utility trenches or drastic changes in the water table, were obviously destined to die. In this connection it should be rememberd that it is very much more expensive to remove large trees after the project is completed than it is before construction of the buildings.

Existing trees that are to remain should be properly fed, pruned by experts and sprayed with insecticide when necessary. Cavity work or cabling is seldom justified unless it is obvious that the vitality of a very fine tree is endangered, or that there is a risk of the tree, or large limbs, falling and injuring tenants or damaging structures.

Tree wells are sometimes justified





Index

A

"Air Gaps and Backflow Preventers," American Standards Association, A40.4, 230
Allotment gardens, 49-50
American Standards Association, 137
    A40.4, "Air Gaps and Backflow Preventers," 230
Apartments, 88, 93
    advantages and disadvantages, 100
    arrangement of buildings, 28-29, 30, 32
    density of, 79-80
    incinerator for, 44, 111
    storage in, 108, 110
    walks for, 42
    See also Flats; Dwelling types
Architect, responsibility of, 3
Ash handling for project plants, 249
Asphalt tile, 212

B

Baby carriages:
    parking for, 42, 61
    ramp for, 144
    storage for, 108, 110
    walk surfacing for, 157
Banks:
    maintenance of, 55, 152
    planting on, 275-276
    slopes for, 55, 151
Barkley, J. F., "Questions and Answers on Boiler Feed Water Conditioning," 249n
Basements, 115
    meters in, 268
Bathroom equipment, 107, 229-231
    lavatory:
        fixture unit value, 222
        for child-service center, 141
        pipe sizing, 227
    tub:
        fixture unit value, 222
        pipe sizing, 227
    water closet:
        fixture unit value, 222
        pipe sizing, 227
Bathrooms, 107
    emergency key for, 208
    interior, 99
    wall finish for, 209
Bedrooms, 106
Bituminous pavement, maintenance of, 154, 157
    See also Surfacing
Boiler room equipment, 248-249
Boiler rooms:
    design of, 245-247
    location of, 247-248
Boilers, 247
    See also Heating
Borings, 18, 187
"Building Materials and Structures Report," BMS 66. National Bureau of Standards, 221, 221n, 228
Bumpers:
    door, 208
    parking, 157
Bureau of Mines, 249
    "Questions and Answers on Boiler Feed Water Conditioning," 249n

C

Cabinet work, 206. *See also* Kitchen equipment; Medicine cabinet
Caissons, 186
Catch basin, 182
Ceiling:
    unplastered, 186, 192
    ventilation of, 195
Cement floor finish, 193-194
Child–service center, 137-141
    play yard, 66
        fence for, 46
Chimney:
    of boiler plant:
        location of, 246
        illumination of, 264
    of dwelling unit, 256
Cinder blocks, 189
Cinder trap, 248
Circulating pump, 229, 248
Circulation:
    in central laundry, 143-144
    in community building, 124, 128, 131, 138, 141
    in site plan, 26, 37-42
City planning. *See* Urban planning
Civil Aeronautics Authority, 264
Cleanouts:
    plumbing, 225-226
    sewer, 178
Clinics, 9, 11
    orientation of, 125
    entrance to, 126
Closet doors, 108
Closets:
    in community building, 128, 129, 131
    in dwelling, 106, 108-110
    insulating value of, 201
    janitor's, 131, 136
        key for, 207
    See also Lockers; Storage
Clotheslines:
    for central yards, 52-54
    for private yards, 50-52
    See also Laundry yards
Clothesline supports, 163
Coal:
    delivery, 45
    kindling for, 45
    used for radiator systems, 251

Coal storage:
  for project plants, 246
  for tenant plants, 45, 112, 256
Codes:
  building, 90
  National Electric, 260, 263
  plumbing, 221
  zoning, 90
Combination fixture (sink and laundry tray), 231-232
  fixture unit value, 222
Commercial facilities, 8-11
  within project, 122
Community buildings, 119-141
  boilers in, 247
  expansion of, 36
  location of, 35-36
  necessity for sketch plans, 25
  relation of principal recreation area to, 59, 62
  See also Laundries; Recreation areas; Tenant tool lockers; Yard stations
Community gardens, 49-50
Community hall, 130, 133, 134
  acoustical material in, 136
Composition board, 209
Concrete:
  floors, 192-193
    covering for, 129, 136-137, 141, 212
    finish for, 193-194
  joists, 192, 193
  piles, 186
  roofs, 195
  sewer pipe, 182
  slab on ground, 191-192
  walls, 189
  See also Surfacing
Condensation, 201-203
  in central laundries, 144
  in dwellings, 232
  on steel sash, 204-205
Construction of buildings, 185-212
  economy in, 98
  See also Parking space; Recreation areas; Service drives; Streets; Walks; Waste collection stations
Control valves for water supply, 228
Corrosion:
  of aluminum foil, 202
  of aluminum sash, 205
  of pipes, 229
  of tanks, 229
Cost:
  capital and operating, factors in, 84, 86
  of basements, 115
  of gas pipe replacement, 176
  of insulation, 201
  of land, relation to dwelling type and density, 75, 77
  of landscaping, 273
  of porches, 115, 116
Cost study. *See* Utility analysis
Coverage, 77
  See also Density
Cracks:
  in floors, 192
  in masonry walls, 188, 193
  in partitions, 198
Crawl spaces, 115
  circuit breakers in, 268
  convenience outlets in, 270
  dampness in, 203
  headroom in, 243
  meters in, 268
  ventilation of, 203
Curbs:
  for parking areas, 156, 157
  for spray pools, 164
  for streets, 155, 156, 161
  for walks, 157
  for waste collection stations, 43
Curb–type inlets, 182

D

Dampproofing, 191
Danger. *See* Hazards
Density, 17, 75-80
  definition of, 75n
  relation of planting to, 276
Dining space, 97, 104
Door bucks, 198, 206
Doors, 205
Downspout:
  connection, 177
  drainage from, 152
  sizing of, 227
Drain:
  fixture unit value, 222
  for central laundry, 145
  for spray pool, 166
  for roof, 195
Drainage, 18, 54-56, 89, 90, 149-154
  of electrical underground equipment, 261
  of foundations, 187
  of plumbing system, 221-227
Drinking fountain:
  fixture unit value, 222
  in community building, 131
  outdoor, 70
Drying space:
  indoor, 111
  outdoor. *See* Laundry yards
Dwelling types, 25, 73-90
  relation to heating system, 90, 237-239
  relation to unit plan, 93-95, 99-102
  See also Apartments; Flats; Row houses; Single houses; Special types; Twin houses
Dwelling unit, 25, 93-116

E

Efflorescence, 188
Electric Code. *See* National Electric Code

Electrical system, 257-270
    exterior, 46, 67, 70, 263-264
    in central laundries, 144
    in community buildings, 130, 131, 270
    See also Lighting fixtures; Utility analysis
Electricity:
    methods of purchase, 218
Electrolysis, prevention of:
    in insulation, 202
    in plumbing, 229
Elevators, 100
Enamel finish for plumbing fixtures, 229
Engineers, responsibility of, 3
Entrances:
    planting at, 277
    protection of, 116, 205
Erosion:
    as maintenance problem, 150
    reduction of, 177, 279
Esthetic considerations, 112-115

F

Family composition. *See* Market analysis
Feed water treatment, 249
Fences, 45-46, 162-163
    as protection from traffic, 59
    for central drying yard, 54, 162, 163
    for child-service center play yard, 141, 162
    for play area, 46, 64
    for service courts, 127
    for waste collection stations, 44, 163
    temporary, 163
Finishes:
    for concrete floors, 193-194
    for plumbing fixtures, 229-230
    plaster, 209
Fire alarm system, 264
Fire hydrants, 170
Fire mains, 168-170
Fire protection:
    for paint shop, 130
    for projection booth, 136
    municipal, 8-9, 25
    project, 121
Fireplaces, 254
Flagpoles, 47
Flashings, 189
Flats:
    advantages and disadvantages, 99-100
    combined with two-story row houses, 47, 88, 101
    definition, 73n
    density of, 79
    storage in, 108
    See also Apartments; Dwelling types
Floodlights, 70, 264
Floor coverings, 129, 136-137, 212
    See also Finishes
Floor furnace, 254
Floors, 191-195
    movement in, 188
Flues, 256
Flush valves:
    for community buildings, 233
    for dwellings, 230
Foundations, 186, 187
Frame walls, 191
Framed concrete floors, 192
Framed wood floors, 194
Fuels, 239-240
    delivery of, 45, 246
    effect on unit planning, 112
    in flats, 108
    storage, 45, 246, 256
    See also Coal; Gas; Heater; Heating; Oil; Utility analysis
Furniture, 97
    bedroom, 106
    dining space, 104
    living room, 103
Furring strips, relation to condensation, 203

G

Garbage. *See* Waste removal
Garden apartments, 89, 101
    See also "Hillside" units
Gardens, community and allotment, 49-50
Gas:
    as fuel, 90, 108, 239, 240, 252
    distribution of, 171-176
    methods of purchase, 218
    See also Utility analysis
Gas burners, 249, 253
    flues for, 256
Gas driers, 250
Grades, 54-56, 149-154
    dwelling types related to, 32-34, 89-90
    of streets, 156
Gutter:
    street, 155, 156
    slopes for, 151
Guying, 260

H

Hall:
    in community buildings, 125, 129, 131
    See also Lobby
Hardware, 207-208
    See also Windows
Hazards, 11-14
    fencing against, 46, 64
    from culverts, 151
    from gas pressure reduction, 171
    from heating units, 116
    from hot-water tank valves, 228
    from location of convenience outlets, 116, 146
    from smoke pipes, 256

  - from spray pool curbs, 164
  - from steps in walks, 152
  - hard surface under playground equipment, 64
  - illumination of, 46, 264
  - of service entrance conductors, 266
  - wire fences, 162
  - *See also* Safety
- Heat controls:
  - for project plants, 249, 250
  - for tenant plants, 251, 253
- Heat exchangers, 242, 243
- Heaters:
  - ceramic, 255
  - maintenance by utility company, 216
  - space heaters, 253
  - triple–service, 252
- Heating plants, 240-243, 251-255
  - expansion of, 245
- Heating system, 236-256
  - relation to dwelling type, 79, 90
  - relation to site development, 45
  - *See also* Hot–water heating
- Hedges, 273, 274-275, 279
- "Hillside" units, 33, 90, 101
  - *See also* Garden apartments
- Hose bibb:
  - location of, 228
  - pipe size for, 227
- Hot–water heating (domestic):
  - controls for, 229
  - non–automatic gas, 228
  - project–operated, 228
  - solar, 234-235
  - tank materials, 229
  - *See also* Valves
- Hot–water piping, return circulation in, 229
- Housing authority, 3
- Hydrants, 169, 170

I

- Imperviousness coefficients, 181
- Incinerators, 44-45, 111
  - relation to laundry yard, 53
- Inspection:
  - of bituminous walks, 157
  - of construction, 187
  - of paving materials, 154
  - of sewer pipe laying, 182
  - of water pipe laying, 170
- Insulation:
  - sound, 199-201
  - thermal, 201-203
- Insulation board on roofs, 195, 203
- "Interlocking" plans, 99

J

- Janitor's closet, 131
  - key for, 207
  - sink in, 136
- Joints:
  - expansion (construction), 193
  - expansion (plumbing), 243, 245
  - relieving (construction), 189, 193
- Joists:
  - bar:
    - floor, 193
    - roof, 195
  - concrete, 193
  - wood, 195

K

- Kitchen, 105-106
  - dining and other auxiliary uses of, 97
  - in community buildings, 131, 136, 138, 141
  - laundry tray in, 111, 231, 232
  - wall finish for, 209, 212
- Kitchen equipment:
  - cabinet, 106
  - hose spray, 232
  - in community buildings, 136, 141
  - laundry tray:
    - fixture unit value, 222
    - pipe sizing for, 227
  - range:
    - maintenance by utility company, 216
    - space behind, 106
  - used to augment heat, 171, 217, 243
  - refrigerator for child–service center, 141
  - sink:
    - fixture unit value, 222
    - pipe sizing for, 227
  - swinging spout, 232
  - tenant–owned, 233
  - triple–service unit, 252

L

- Land. *See* Site selection
- Land use. *See* Site planning
- Landscape architect, 273
- Landscaping, 273-282
- Laundries:
  - central, 111, 142-146, 233
  - for child–service center, 141
  - in dwellings, 111, 231-232
- Laundry equipment:
  - for central laundries, 144, 145, 146
  - laundry tray:
    - fixture unit value, 222
    - pipe sizing for, 227
  - mechanical driers, 144, 250
- Laundry tray. *See* Kitchen; Laundry equipment
- Laundry yard equipment, 50-52, 53, 54
  - clothesline supports, 163
- Laundry yards, 50-54
  - central, surfacing for, 158
  - relation to central laundries, 143
  - slopes for, 151
  - *See also* Drying space

Lavatory. *See* Bathroom equipment
Lawn, 273, 276
  drainage of, 151, 152
  maintenance of, 279
  shape of, 279
  slope of, 55, 151
Leader, sizing, 227
  See also Downspout
Leakage:
  in walls, 187-188
  around entrance doors, 205
Libraries, 9, 11
  in community buildings, 133
Lighting fixtures:
  exterior, 70, 263-264
  interior, 269-270
  maintenance of, 270
  replacement of parts, 269
"Livability Problems of 1,000 Families, The," National Housing Agency, Federal Public Housing Authority, 96-97, 97n
Living room, 103-104
  use of, 97, 103-104
Lobby, for community building, 126, 131
"Local Housing Authority and the Architect, The," Oliver C. Winston, 3
Lockers:
  in child-service centers, 141
  in central laundries, 146
  for garden tools, 146
Locks. *See* Hardware
Loop system:
  electrical, 258
  gas, 176
Lunch room for project employees, 128, 129

M

Macadam. *See* Surfacing
Machine room design, 246-247
Mail boxes, 208
Mains:
  fire, 168, 169, 170
  gas, 172, 176
  heating, 242, 243, 244, 245, 251
  sewer, 180, 182
  water, 167, 168
    valves in, 170
Maintenance:
  methods, early formulation of, 25
  relation to dwelling type, 84
  See also Banks; Bituminous pavement; Lighting fixtures; Multiple sites; Parapet walls; Roofs; Screen door hardware; Sewers; Spray pools; Streets; Surfacing; Utility analysis; Walks; Walkway edging; Window panes
Maintenance space, 129-130
  delivery to, 127
  lighting of, 270
  location of, 35, 122
  orientation of, 125
  service entrance for, 126
  necessity for sketch plans, 25
Management:
  effect of land use policy on, 47
  maintenance of planting, 275
  meter reading, 268
  methods, early formulation of, 25
  operation of sewage treatment works, 177
  sources contributing to "Public Housing Design," vi, 96-97
Management space, 128-129
  location of, 35, 36
  orientation of, 125
  relation of recreation areas to, 62, 127
  necessity for sketch plans, 25
  waiting room design, 123
Managers, advance consultation with, 123
Manholes:
  in heating system:
    avoidance of, 245
    dampness in, 244
    for coal dumping, 246
  in sewer system, 178
Maps, 19
Market analysis, 86
Masonry walls:
  cracks in, 188
  dampproofing of, 191
  for play areas, 163
  for waste collection stations, 44, 163
  insulation of, 203
  leaking, 187-188
  paint on, 210
Mechanical driers. *See* Laundry equipment
Medicine cabinet, insulation of, 199
Metal lath, 198
Metal pans for concrete floors, 193
Meters:
  check meters, 267, 268
  electric, 268
  gas, 176, 268
  water, 167
  See also Utility analysis
Millwork, 206-207
"Minimum Physical Standards," National Housing Agency, Federal Public Housing Authority, vi, 8, 31, 36, 73, 115, 199, 200, 201, 236
Modular design, 98
Motion picture projection booth, 136
Multiple sites, 15, 17
  maintenance of, 17
Municipal services. *See* Fire protection; Libraries; Police protection; Sewerage; Street illumination; Utilities; Waste disposal; Water supply

N

National Board of Fire Underwriters, 137, 260n
  "National Electric Code," 260, 263

"Standard Schedule for Grading Cities and Towns," 169n
National Bureau of Standards:
    "Building Materials and Structures Report," BMS-66, 221, 228
    "Recommended Minimum Requirements for Plumbing," BH 13, 221
    "Research Paper RP-1602, Soil Corrosion Studies," 234
"National Electric Code," 260, 263
National Housing Agency, Federal Public Housing Authority:
    "Livability Problems of 1,000 Families, The," 96-97, 97n
    "Minimum Physical Standards," vi, 8, 31, 36, 73, 115, 199, 200, 201, 236
Neighborhood:
    unit, 5-7
    pattern, conformance of dwelling type to, 80-84
    shopping, 8, 9-11
Noise:
    from children's play, 36, 41, 88, 127
    from project surroundings, 11, 28
    from pumps, 248
    from water closets, 230
    in community buildings, 125
    in high-pressure steam lines, 245
    in water pipes, 228
    See also Sound insulation
Nuisances, effect on site selection, 11-14
Nursery. *See* Child-service center

O

Office space. *See* Management space
Oil burner, 249
Oil fuel, 239, 240, 252
    delivery, 45
    storage, 256
Oil paint. *See* Paint
Orientation:
    of community buildings, 125, 138
    of dwellings, 35

P

Paint, 210-212
    See also Finishes
Paint shop, 130
Parapet walls, 188-189
    maintenance of, 188
Parking space, 38-40, 156-157
    slopes for, 151
Partitions, 197-198
    sound-reducing characteristics of, 200
Pavements. *See* Surfacing
Party walls, insulation of, 199, 200, 201
Perambulators. *See* Baby carriages
Perrons, 152
Piles, 186
Pipe joints, 170
Pipes, freezing of, 228, 229
Pipe materials:
    for gas, 176
    for heating, 244
    for sewers, 182
    for water, 170, 233-234
Pipe sizing:
    fire main, 168-169
    gas, 172
    leader, 227
    sewer, 178, 182
    vent, 226
    water, 222, 227-228
Pipe tunnels, 244
Planning, economy of, 98
    relation to architectural style, 112
Planting, 273-282
    to screen waste collection station, 44
Plaster, 209
    on solid slab, 186, 192
Plaster substitutes, 209-210
Play area. *See* Recreation area
Play space in connection with central laundries, 145
Playground equipment:
    location of, 63, 68-70, 141
    storage for, 59, 66, 128
    surfacing under, 64, 159
Plumbing, 221-235
Plumbing fixtures, 229-233
    replacement of fixture trim, 230
Plywood forms, 192
Police alarm system, 264
Police protection, municipal, 8, 25
Police station, 121
Pool:
    spray, 63, 64, 65, 164-166
    wading, 65
Porches, 115-116
    prevention of settlement, 187
    for play areas, 123
Post office, 121
Power factor, electrical, 257
Pressure-reducing valves, 228
Privacy:
    effect of heating grilles on, 251
    in flats, 99
    in row houses, 99
    relation to building spacing, 31
    relation to lack of fences, 46
    secured by street design, 28
Project plant. *See* Heating
"Public Health Service Drinking Water Standards and Manual of Recommended Water Sanitation Practice," U. S. Public Health Service, 170n
Public vestibule:
    lighting of, 270
    See also Hall; Lobby
Pumps:
    for sewage, 178
    foundations for, 248
    in machine rooms, 246
    See also Circulating pumps

Q

"Questions and Answers on Boiler Feed Water Conditioning," J. F. Barkley, 249n

R

Radial system:
  electrical, 258
  gas, 176
Radiator valves, 250
Radiators, 242, 243, 251, 252
  air binding in, 243
  location in bedrooms, 106
Radio systems, 270
Rainfall intensity, 180-181
Ramps, 41, 152
  slopes for, 151
Range. *See* Kitchen equipment
"Recommended Minimum Requirements for Plumbing," BH 13, National Bureau of Standards, 221
Recreation agencies, public:
  allocation of playgrounds, 59-60
  consultation with, 59, 68, 123
Recreation areas, 57-70
  availability of off–site, 8-11
  fences for, 46, 64, 162
  for child–service centers, 141
  relation to community buildings, 36, 127
  slopes for, 56, 151
  surfacing for, 158-161
  See also Spray pools
Recreation director:
  office for, 59, 66, 128, 131
Refrigerators:
  as factor in electric load, 257
  maintained by utility company, 216
  See also Kitchen equipment; Utility analysis
Relief valves, 228
Rent:
  dwelling types related to, 84-86
Repair shop, 129, 130
Repairs. *See* Utility analysis
Replacements:
  of lighting fixture parts, 269
  of plumbing fixture trim, 230
  of smoke pipes, 256
  of transformer units, 263
  See also Utility analysis
Research Paper RP-1602, "Soil Corrosion Studies," National Bureau of Standards, 234
Rest room, 128
Road. *See* Street
Roof coverings, 197
Roofs:
  flat, 195-196
  maintenance of, 195
  pitched, 196-197
Room sizes, 97
Row houses:
  advantages and disadvantages, 99
  arrangement of buildings, 29, 32
  combined with other types, 79, 88, 101
  density of, 75, 78
  heating for, 237
  walks for, 42
  See also Dwelling types; Special types
Rubbish. *See* Waste removal
Runoff coefficients, 181-182

S

Safety:
  exits for, 93, 125-126
  fences for, 45, 46
  household, 116
  stair design for, 110
  See also Hazards
Sandboxes, 64, 68, 69
Schools, 8-11
  within projects, 122
Screen door hardware:
  maintenance of, 207
Screens, 205-206
Septic tanks, 177
Service drives, 37-38, 155-156
  materials for, 154
  slopes for, 151
Service sink:
  fixture unit value, 222
Service strips:
  use in site planning, 27
Service structures, 142-146
  See also Community buildings
Sewers:
  combined, 177-178, 180-182
  maintenance of, 180
  materials for, 182
  municipal, 8-9, 25, 177
  project–operated, 177
  sanitary, 177, 178-180
  storm, 177, 178, 180-182
Sheathing, 191
Shop. *See* Commercial facilities; Paint shop; Repair shop
Shower:
  fixture unit value, 222
  in maintenance space, 129
  pipe sizing for, 227
Shower head, 230
Shut–off valves, 228
Single houses:
  density of, 77
  See also Dwelling types
Sink. *See* Kitchen equipment
Site engineering, 149-182
  disposal of storm water, 177-178
  erosion, 150
  peak–hour loads for space heating (gas), 171-172
  protection of water supply, 170

Site illumination, 46, 263-264
  municipal, 25
Site planning, 23-70
  land use, 47-49
  organization, 25-26
  service strips, 27
  superblock, 26-27
  texture, 27-28
Site selection, 5-20
  check list for, 20
  relation to housing objectives, 15
  relation to urban planning, 5-8, 25
  work material for, 19
  See also Neighborhood
Sitting areas, 61, 66-67
  slopes for, 151
  surfacing for, 159
Smoke pipe, 256
Soil:
  contamination of, 234
  for community gardens, 49-50
  See also Topsoil
"Soil Corrosion Studies." Research Paper RP-1602, National Bureau of Standards, 234
Solar heat:
  for domestic hot water, 234-235
Sound insulation, 197, 199-201
Space heaters, 253-255
Spacing of buildings, 31-32
Spandrels, 193
  flashing of, 189
Special types (of dwellings)
  combined flats and row houses, 101
  garden apartments, 89, 101
  "hillside," 33, 90, 101
  quadruplex, 101
  quatrefoil, 101-102
  row houses, half story below grade, 90
  See also Dwelling types
Spray pools, 63, 64, 65, 66, 164-166
  maintenance of, 64
Stair hall, 110
Stairs, 110, 206
"Standard Schedule for Grading Cities and Towns," National Board of Fire Underwriters, 169n
State Health Department:
  approval for sewerage systems, 177
Stepping stones, 152, 157
Steps:
  at entrances, 187
  in walks, 41, 152
Stoker, 240, 245, 248
Stop valves, 243
Storage:
  for community buildings, 128, 129, 131, 134
  for garden produce, 50
  fuel, 45, 112, 256
  in basements, 108, 110, 115
  in dwellings, 97-98, 108-110
  playground equipment, 59, 66, 128
  See also Closets; Lockers; Yard stations
Street signs, 47
Streets, 37, 155-156
  buildings in relation to, 28-29
  closed for play area, 67
  maintenance of, 154
  materials for, 154
  slopes for, 151
  See also Surfacing
Structure, 185-212
Structural system, 185-197
  relation to plan and materials, 98
Subsoil, 18-19, 25, 90, 150, 154, 178, 186, 187
Superblock, 26-27
Superintendent's office:
  location of, 127, 129
Supervision:
  in central laundries, 142, 144, 145
  in community spaces, 125, 126, 128, 129, 131, 141
  in play areas, 59, 60, 63, 66, 68, 69, 70
  See also Inspection
Surface finishes. *See* Finishes; Paint
Surface grating:
  for sewers, 182
Surfacing, 154-161
  at entrances, 277
  for private laundry yards, 52
  maintenance of, 160
Swales, 54, 55, 151-152, 153
Swinging spout. *See* Kitchen equipment

T

"Table of Required Fire Flow," National Board of Fire Underwriters, 169n
Tanks:
  expansion, 251
  for water closets, 230
  fuel oil, 256
  hot–water storage, 229, 234, 235
  See also Septic tanks
Telephones, 264
  location of public, 47, 131
Tenant:
  characteristics, 86-88
  grounds maintenance by, 47-49, 93-94, 274-275
  needs, 86-88
Tenant-owned equipment:
  storage of, 233
Tenant tool lockers, 146
Tenant yards, 97, 99
  fences for, 45-46, 162
  slopes for, 151
  See also Laundry yards
Termite control, 208
Terraces for community buildings, 62, 127, 128, 141
Texture of site plan, 27-28
Thermostat, 249, 250, 251
Tile:
  asphalt, 212

    floor, 192
    roof, 197
    wall, 190-191
        dampproofing of, 191
Toilets
    for community buildings, 128, 131, 134, 136, 138, 141
        urinals for, 233
    for picnic grounds, 67
    for play areas, 62, 66
    in central laundries, 144
    See also Water closet
Topography, 18-19, 32-34, 89-90, 149, 152
Topsoil, 56, 150
Toxic treatment of wood, 208
Traffic:
    in walks, 41
    relation of buildings to, 28, 29
    See also Circulation; Hazards
Traffic control signs, 47
Transformer stations, 260, 262-263
Transformers:
    replacement of, 263
    sizing of, 260
Transportation to off-site facilities, 8-11
Traps:
    heating, 243, 245
    plumbing, 221, 224, 226, 230, 232
Tray. *See* Laundry equipment
Trees, preservation of, 25, 56, 281-282
Trim, 206-207
Truss, lightweight roof, 196-197
Tub. *See* Bathroom equipment
Turf for recreation areas, 65, 66, 159, 160
Twin houses, 77, 94
    advantages and disadvantages, 99
    arrangement of buildings, 29, 32
    definition of, 73n
    storage in, 108-109
    walks for, 42
    See also Dwelling types

U

Underwriters' Laboratory, 137n
    See also National Board of Fire Underwriters
U. S. Department of Agriculture, Miscellaneous Publication 204, "Rainfall Intensity—Frequency Data," 180
U. S. Public Health Service, "Public Health Service Drinking Water Standards and Recommended Water Sanitation Practice," 170n
Urban planning, 5-8, 25
    See also Neighborhood
Urinals:
    fixture unit value, 222
    for community buildings, 233
Utilities supplied by municipality, 8-9
Utility analysis, 215-217
    cost study, 215
    energy, 216-217
    fuel, 216-217
    gas, 216, 217
    maintenance, 216
    meters, 217
    refrigeration, 215, 216, 217
    repairs, 216
    replacements, 216
Utility rate negotiations, 218
Utility rooms 109-110
    laundry trays in, 231
Utility selection, 215-218

V

Vacuum process for concrete, 193
Vacuum vent valves, 243
Valves:
    for hot-water storage tanks, 228
    in gas distribution, 176
    in water distribution, 170
    ventilation for, 245
    See also Control valves; Flush valves; Pressure-reducing valves; Shut-off valves; Stop valves; Vacuum vent valves
Vapor barriers, 203
    below ceiling, 196
    metal foil as, 201
    See also Insulation
Ventilation:
    of bathroom, 107
    of boiler room, 245
    of central laundry, 144
    of food storage space, 109
    of machine room, 246-247
    of maintenance space, 130
    of manholes, 244
    of mechanical driers, 144, 250
    of tenant heating plant, 251
    of transformer stations, 263
    under roofs, 195, 196
    See also Condensation
Vents, 222, 226
Vines, 279

W

Wading pool, 65
Walks, 40-42, 157-158
    illumination of, 46, 263
    maintenance of, 42
    shrubs at intersections of, 279
    slopes for, 151
Walkway edging, maintenance of, 158
Walls, 187-191
    cavity, 190
    cracks in, 188, 193
    flashing of, 189
    foundation, 186-187
    parapet, 188-189
    See also Frame walls; Masonry walls

Washing machines
    in central laundries, 143, 144
        outlets for, 146
    in dwellings, 97, 110, 111, 231
Waste collection stations, 43-45
    fences for, 46, 163
Waste removal, 8, 25, 43-45, 93, 94, 111
Water
    corrosion, 233-234, 249
    distribution, 167-170, 227-228
    hammer, 243
    on roofs, 195
    See also Heating system; Hot-water heating
Water closet. *See* Bathroom equipment
Water meters, 167
Water supply, municipal, 8-9, 25, 167
Waterproofing, 189
    See also Dampproofing
Weatherstripping, 205
Weep holes in cavity walls, 190
Window panes, maintenance of, 204
Windows, 204-205
Winston, Oliver C., "The Local Housing Authority and The Architect," 3
Wood:
    floors, 194-195
    frame walls, 191
    paint retaining quality of, 211
    roofs, 195-196
    studs, 197, 200
    toxic treatment of, 208

Y

Yard lighting, 263-264
Yard stations, 146
Yards. *See* Laundry yards; Tenant yards
Yarnell, David L., "Rainfall Intensity—Frequency Data," 180

Z

Zoning, 8, 90
    See also Neighborhood

☆ U. S. GOVERNMENT PRINTING OFFICE: 1946—672584

PUBLIC
HOUSING
DESIGN